



# DESIGN REQUIREMENTS AND GUIDELINES

Coachillin' Industrial Cultivation & Ancillary Canna-Business Park - **UPDATED MAY 24, 2020**





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# INTRODUCTION





This SPECIFIC PLAN is a guide to the proposed Coachillin' Industrial Cultivation & Ancillary Canna-Business Park development consisting of 153.71 gross acres (149.69 net acres). The Specific Plan property is bounded by Indian Canyon Drive, a major arterial, to the West; Calle De Los Romos, a secondary street, to the East; 18th Avenue, a secondary street, to the North; and 19th Avenue, a secondary street, to the South, in the City of Desert Hot Springs (the "City"). The proposed development site will have approximately 143.79 net acres after street and driveway dedications.

COACHILLIN' HOLDINGS LLC, the Project Applicant, proposes to replace the existing Palm Springs Desert Commerce Center, which was approved by the County of Riverside and subsequently adopted by the City of Desert Hot Springs whom annexed the subject property/Project in 2010; the Project entitlements were recently extended through November 2017; which occurred at the Planning Commission meeting on June 13, 2017. The new Coachillin' Industrial Cultivation & Ancillary Canna-Business Park (the Proposed Project) intended to update the existing entitlements to reflect current conditions and respond to changing market conditions relative to future development in the Project area.

The Proposed Project is intended to update the existing entitlements to reflect current conditions and respond to changing market conditions relative to future development in the Project area.

The Plan's objectives provide for the successful, responsive and valuable development of this vacant property in a manner consistent with the City of Desert Hot Springs General Plan and other applicable planning documents. This Plan meets all requirements of California Planning Law and represents the results of a collaborative planning effort by the City, CEQA legal counsel, property owners, designers, environmental consultants and service agencies.

The Coachillin' Specific Plan, presented by COACHILLIN' HOLDINGS LLC (the "Applicant") proposes to develop a Coachillin' Industrial Cultivation & Ancillary Canna-Business Park, including multiple critical and ancillary businesses which –at full buildout– will make up over three million (3,000,000) square feet of Industrial Cultivation Facilities, and ancillary uses.

**The Park will have all of the following Infrastructure Components:**

1. Power supplied by SCE, and created on-site by Natural Gas Micro-turbines & Reciprocating Engines (for CCHP applications), Wind Turbines, Solar covered parking structures.
2. Domestic Water provided by MSWD.
3. Cultivation & Landscape Irrigation Water provided by a 750' on-site water Well and 4,000,000-gallon water storage reservoir and distribution system.
4. Discharge Water handling through an Anaerobic Digester Unit (off-site), cannabis wastewater reclamation phytoremediation system (on-site).
5. Security in a protected compound environment behind Perimeter block walls (like that of a US Embassy).

**In addition to traditional Cultivation facilities, the Park will have the following mixed-use zoning and amenities:**

1. TOURING & EDUCATION FACILITY (Parcel #29) with a micro-grow, micro-extraction, micro-canning, inside & drive thru sales, industry showcase, dispensary, and a roof top restaurant and/or private members-only club.

2. LAB TESTING & MANUFACTURING FACILITY (Parcel #32) containing Independent Testing Lab, multiple botanical Extraction & Manufacturing labs, Industrial kitchens; Nitrogen-Sealed Product Canning Facility, and Storage Suites.
3. Security tactical operations center, bunkhouse, armory, & technology command center / server basement level.
4. RESEARCH & DEVELOPMENT INCUBATOR (Parcel #33) containing Research Greenhouses, Indoor Research G-Cells; and Portable re-purposed shipping containers.
5. VERMICULTURE (RED WORM) FACILITY (Parcel #39); Vermiculture technology will be used in the Project as an "environmentally sustainable", "economically viable" and "socially acceptable" technology all over the world. 1) Vermi-composting Technology (to manage most organic wastes); 2) Vermi-filtration Technology (to treat municipal & several industrial wastewater); 3) Vermi-remediation Technology (to treat & clean up contaminated lands); 4) Vermi-agro-production Technology (to produce chemical-free organic foods by worms & vermi-compost); 5) Vermi-industrial Production Technology (to produce valuable industrial raw materials from worms). The use of earthworms as "waste managers" for efficient "composting of food and farm wastes" and as "soil managers" for "fertility improvement" and enhanced "farm production" were known for ages but now it is being more scientifically and also commercially revived. This facility will also contain an Aquaponics Grow Research and Development Grow Unit. Aquaponics is the combination of aquaculture (raising fish) and hydroponics (the soil-less growing of plants) that grows fish and plants together in one integrated system. The fish waste provides an organic food source for the plants, and

the plants naturally filter the water for the fish. The third participants are microbes (nitrifying bacteria). These bacteria convert ammonia from the fish waste first into nitrites, and then into nitrates. Nitrates are the form of nitrogen that plants can uptake and use to grow. Solid fish waste is turned into vermi-compost that also acts as food for the plants. In combining both hydroponic and aquaculture systems, aquaponics capitalizes on their benefits, and eliminates the drawbacks of each.

6. Ancillary BUSINESS DISTRIBUTION FACILITIES for lighting, HVAC, SIPS panels, Racking systems. All support for the Cultivation projects within the Project.
7. Three (3) Producing DATE & CITRUS GROVES, plant nursery, and phytoremediation systems (Parcels #101, #102 & #103) to be located in the WQMP retention basins on the south side of the property. Plant nursery. An Agricultural HEMP wastewater phytoremediation system. This system is an outdoor production facility located in (AG Basin #101, #102, #103) used to Phyto-remediate cannabis waste water generated within the Park naturally restoring cannabis waste water to a clean state and allowing its re-use or surface recharge of the local aquifer.
8. RESTAURANTS AND OTHER COMMERCIAL ZONING USES in parcels abutting the main arterial Indian Canyon Drive; Including a Hotel/Resort, Amphitheater events venue, among other things.
9. A 7.0 acres Private electrical substation and other Industrial Energy & Utilities (IE) uses is proposed on Parcel #25.

The proposed Project building heights would be a maximum of three sixty-five feet (65') for interior parcels, and fifty-five feet (55') for Parcels along

perimeter public roadways Indian Canyon Drive, 18th, 19th, and Calle De Los Romos with architectural features consistent with a modern high-quality Industrial park.

#### GUIDELINE

**Coachillin' Industrial Cultivation & Ancillary Canna-Business Park** is committed to achieving greater sustainability throughout its developments. This guideline is provided to assist the purchaser and their chosen designers to achieve a more energy, water and resource efficient development, and the blend of well-designed buildings and quality landscaping.

The guideline will ensure that this is maintained throughout the final stages of development, providing an advantage to all industries and businesses that choose to locate their operations within Coachillin' Industrial Cultivation & Ancillary Canna-Business Park.

#### GUIDELINE STRUCTURE & HOW TO USE THIS DOCUMENT

This guideline reflects the general flow of site and building design in the context of Desert Hot Springs. It is generally organized in a descending order of scale, from overall site planning concerns, to circulation issues, to buildings, site details, and then signs and exterior lighting. The first third of the guidelines are about Site Planning, Vehicular Circulation and Parking and Loading Areas, Architectural Design, and Landscape Design. These chapters of the guidelines address integrated building design, site networking, and landscaping as these considerations are key to achieving high levels of efficiency. Fences and walls, signs, and lighting design are the following chapters, which provide the idea of integrating these into the architecture of the structure. Managing recommendation of waste, stormwater, construction, and energy can be found in the last chapters.

At a conceptual level, this integration can occur when considering networking opportunities, and siting and orientation, while details are usually worked out through later stages of the design process.

***This Specific Plan and Design Guidelines documents are intended to allow some flexibility in their requirements.***

Should an applicant have a unique idea, design, or other situation related to only the following (1) height, (2) setbacks, (3) screening, or (4) parking requirements that renders the strict application of the Specific Plan infeasible, the applicant may apply to the Planning Commission for approval of their project/structure. The consideration of the application by the Planning Commission need not be a public hearing. The Planning Commission's determination of the application shall be discretionary and up to the Planning Commission. The Planning Commission's decision may be appealed to the City Council pursuant to DHSMC Chapter 17.104, as may be amended.

#### ACCEPTABLE VARIANCES

In the case where a variance from the Design Guidelines is needed and/or required, the applicant must obtain approval from the Property Owners Association, as well as approval from any potentially affected owner of an abutting property.

# CHAPTER 1

## PERMITTED USES



# Chapter 1 - PERMITTED USES

## 1.1 - Permitted Uses for Different Parcels

The Coachillin’ Specific Plan, presented by the Applicant proposes to develop a Mixed-Use Industrial Cultivation & Ancillary Business Park, including multiple critical and ancillary businesses which make up over 3,000,000 square feet of Cannabis Cultivation Facilities and other ancillary business facilities. For permitted uses in each parcel see table of permitted use in this page.

Implement Specific Plan whereby future tenants and future Parcel Owners will not have to file individual CUP’s under an approval CUP for project; only Regulatory Permits; Site Specific CUP’s and Development Plan Permit Review subject to Design Review Guidelines attached hereto, and City and State Regulatory review processes.

**Development Plan Permit:** for all Permitted uses including mixed-use Cannabis cultivation, lab/ extraction, distribution-transport, storage industrial park containing multiple ancillary businesses and an open to the Public Tour/Dispensary facility;

**Conditional Use Permit:** to allow on-site alcohol sales in appropriately designated mixed-use areas; Cannabis cultivation; Botanical Oil Extraction, Cannabis sales; Cannabis Distribution; Cannabis Transportation, Water Storage Reservoir, Anaerobic Digestion, Helipad.

The Coachillin Specific Plan Land Use Program has been designed to be consistent with the City of Desert Hot Springs General Plan, and Zoning Code land uses in order to be in conformance and for ease of use and application. This will apply to both the Specific Plan allowable land uses as well as the required permit review and approval process. **Table 3-4 in the Coachillin Specific Plan** represents those uses in the Specific Plan, which are subject to permit review and approvals.

They include the following (please note this information can also be found immediately following Table 3-4):

- **“Permitted Uses” (P)** requiring Administrative Development Permit; Permitted Uses (P) under this Coachillin’ Specific Plan may also be referred to as “Specific Plan-NRC” (SP-NRC) Specific Plan Not Requiring a Conditional Use Permit (aka “by-right” permitted use) throughout this document;
- **“Conditional Uses” (C)** requiring a Conditional Use Permit;
- **“Temporary Use” (T)** requiring a Temporary Use Permit;
- **“Not Allowed” (X)** not allowed in project.

The organization and numerical ordering of Table 3-4 is based on the Standard Industrial Classification System as defined in Section 17.04.020 of the City of Desert Hot Springs Zoning Ordinance. It is not expected that the range of uses set forth below is all inclusive. Cases of uncertainty regarding whether a particular land use is permitted and by what process, shall be determined by the Community Development Director.

Table 3-4 also compares the Specific Plan’s allowable uses and permit requirements with the existing LI Zoning in addition to other related/mixed uses allowed & permitted under other City of DHS zoning guidelines. Many uses allowed in the LI Zone have been excluded from the Coachillin Use Plan. As shown, the Coachillin SP proposed allowable uses very closely resemble the currently allowed uses.

### ACCEPTABLE VARIANCES

In the case where a variance from the Design Guidelines is needed and/or required, the applicant must obtain approval from the Property Owners Association, as well as approval from any potentially affected owner of an abutting property.



# CHAPTER 2

## SITE PLANNING



## Chapter 2 - SITE PLANNING

The main goal for all types of development within the **COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK** should be to create a functional and visually interesting environment, adhering to the unique conditions of the site while maintaining the high design standards.

In this section relationships of elements on the business park, such as orientation of abutting properties and building's location within a property, public circulation and private access to the parcels, and parking orientation will be considered.

In general, well-designed and considered publicly owned or privately maintained landscape area, outdoor common area, well-linked pedestrian and vehicle network, and characteristically unique architecture design rather than a simple big box, are encouraged by the Owner's Association.

### GUIDELINES

#### 2.1 - Building Siting and Orientation

Not only should all properties be designed to provide generously planted landscape setbacks to decrease the visual impact of giant buildings, but buildings should also be designed to create an attractive impression from the street.

For increasing access to the natural light and fresh air for adjoining properties, avoiding overcrowded area, and reducing shadow impact, buildings should be separated from one another with an appropriate space.

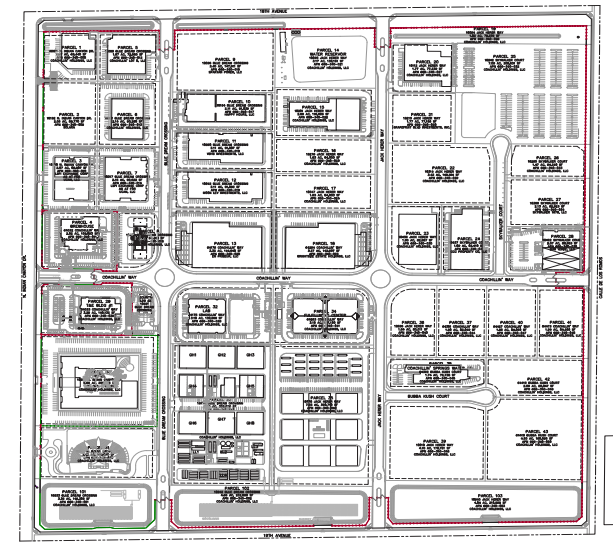
1. Large enough and well-designed landscape setbacks, highlighted entries, and well-linked circulation contribute to the campus-like feel of the Business Park.

2. Sun exposure should be maximized by properly locating and orienting buildings, landscape and other elements within a property.
3. Locate buildings close to the main street. If more setback is required in front yard because of architectural design or any other circumstances, 75% of the front building facade should follow the same 'build to' line that setback regulation has been set.
4. Emergency vehicle access is important, and must be a priority in any parking and building access design. A project-wide emergency & fire access plan has been prepared for the entire site in order to allow individual parcels to maximize buildable square footage. Building designs should accommodate the fire access plan's predefined areas.
5. Entries of the site and the building shall be well defined, clearly visible and allow for ease of access.
6. On corner properties, adjacent sides of the building to the public streets should have similar architectural form.
7. Features such as access, parking, service and utility areas, should be shared with at least one abutting site.

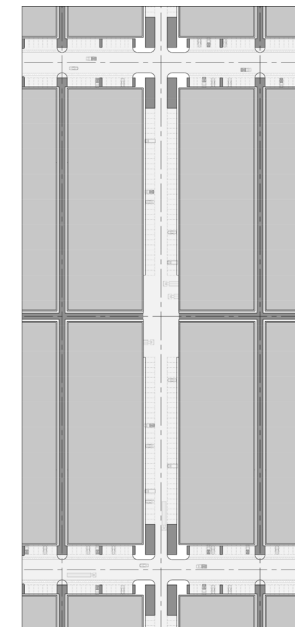
#### 2.2 - Building Setbacks

To organize structures and activities on the site, reduce visual impact to users and spectators, and harmonize street-face buildings, all developments must obey setback regulations.

1. To have aligned building facades and uniform street edges, front side of all building's setback, in first two floors should be 50 feet from the adjacent street center line. The third floor step back, which assumingly would be a greenhouse, should be minimum 70 feet from street center line.



FINAL SITE PLAN (Appendix A)



OVERALL SITE PLAN CONCEPT (Appendix B)

2. Corner lots should follow the 50 feet setback rule from their two abutting sides to the streets. The third floor step back, should be a minimum of 70 feet from street center line.
3. In each parcel building setbacks should follow the values in the table below.
4. Except for overhang elements which are defining entrances in front yard, no portion of any building shall encroach or project into the setback.
5. All project elements, that do not include floor area, such as roof eaves or other architectural enhancements, may encroach into the above setbacks a maximum of three feet (3').
6. All setbacks are minimum; greater setback is encouraged, particularly in the internal access road.
7. Mechanical equipment may encroach in the setback areas, provided the height of the encroaching equipment does not exceed 20 feet (20'), and that the equipment is properly screened.

### 2.3 - Pedestrian Amenities

In an industrial site, well-designed streetscapes, safe, and visually attractive paths, are as important as a well-linked circulation network throughout the business park and parcels. All requirements for walkways on interior private streets have been waved per recommendation of City Council approval by the Desert Hot Springs

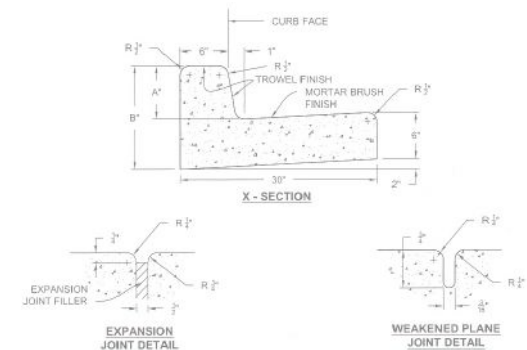
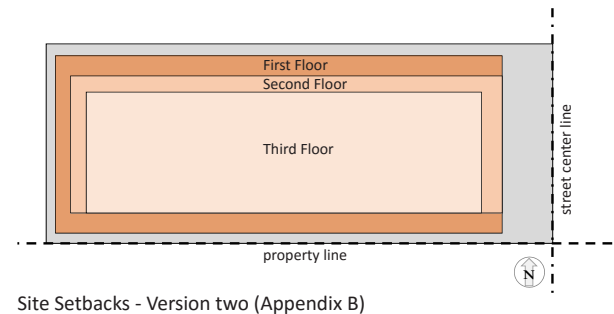
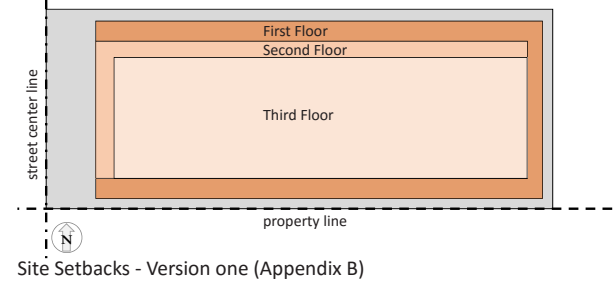
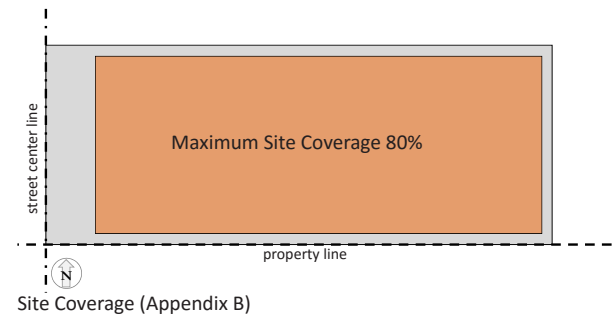
#### COACHILLIN INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK BUILDING SETBACKS

| LEVEL | EAST WALL (FT)** | WEST WALL (FT)** | NORTH WALL (FT)** | SOUTH WALL (FT)** | STREET WALL (FT)* | CITY ROADS (FT)** | HEIGHT (FT) *** |
|-------|------------------|------------------|-------------------|-------------------|-------------------|-------------------|-----------------|
| 1     | 10               | 10               | 10                | 10                | 50                | 15                | 27'-6" (MAX.)   |
| 2     | 25               | 25               | 30                | 30                | 50                | 15                | 27'-6" (MAX.)   |
| 3     | 25               | 40               | 45                | 30                | 70                | NA                | 18'-0" (MAX.)   |

\* SETBACK FROM CENTER OF THE ROAD  
 \*\* SETBACK FROM PROPERTY LINE  
 \*\*\* MAXIMUM HEIGHT 65'-0"

Planning Commission (for the extent that the project remains private). Additionally, exterior sidewalks have been limited to those along the main arterial Indian Canyon Drive. Sidewalks will not be installed along secondary streets (e.g. 18th, 19th, and Calle De Los Romos) due to security concerns shared by DHS Chief of Police. In the event the project becomes public, the following shall apply:

1. All walkways along the main streets throughout the business park should provide pedestrian network.
2. Accessibility, safety, and being well defined by decorative pavement, landscaping, low walls, and low-level lighting are objectives that should be considered in pedestrian walkway design.
3. Sidewalks should be continuous and mostly straight, and connected to a public open space.
4. On every public street, provide a comfortable sidewalk –at least four (4') feet in width– that can accommodate pedestrian flow and activity.
5. Use landscape and street furniture such as trees, benches, and lighting to create a buffer zone between vehicles moving area and pedestrian moving path (except curb parking on street; stripped sidewalk). This buffer should be at least five feet (5').
6. Sidewalks within parcels should be at least four (4') feet in width.



- Pedestrian pathways and vehicular drive areas (outside of parcels) should be clearly identifiable by the use of different paving texture, color and materials.
- Clearly distinguish crosswalks (outside of parcels), by using bright color or raising the pedestrian paving surface (Figure 2-1).

## 2.4 - Site Coverage Requirements

Each parcel may contain buildings, parking, driveway, landscape, and open spaces. Designed and well-maintained landscape area and open spaces are value amenities.

- The maximum building coverage within each parcel is 80%. Exceptions in excess may be considered, provided that all other setback requirements are met.
- The minimum amount of landscape coverage provided within an industrial development is 10%. Greater percentage landscape coverage is encouraged.
- All installed equipment, electrical rooms and services rooms should be designed within the footprint structure.

## 2.5 - Utilities, Mechanical, and Telecommunications Equipment

Building design should mitigate the visual and noise impacts of utilities, mechanical equipment, cooling towers, data transmission dishes, communication towers, and similar antennas & equipment. These types of equipment are allowed to be located abutting the block wall, on the downhill side of any parcel, and encroach within the setback area, provided adequate clearance is provided for service and maintenance.

- Roof mounted equipment such as compressors, air conditioners, pumps, heating and ventilating

equipment, emergency generators, chillers, elevator penthouses, water tanks, stand pipes, solar collectors, satellite antenna dishes and communications equipment should be fully screened and not be visible from the street (Figure 2-2).

- Utilities should be shielded architecturally from the direct line of sight of crosswalks and sidewalks.
- Utilities such as power lines, transformers, and wireless facilities should be placed underground or on rooftops and appropriately screened.
- Only during construction, temporary overhead power and telephone facilities may be permitted.
- Any kind of attached equipment to the building is not permitted. The only exception are Communications towers (or antennas). These antennas should be designed and attached to the building in a way in which they blend with the main building design and be part of the main building.

## 2.6 - Service, Delivery and Storage Areas

Service, delivery and storage areas should be carefully located in order to mitigate their visual impact; especially views of such areas from public ways and along designated view corridors.

- All refuse, equipment areas, loading docks, outside storage, and service areas should be contained within the footprint of the parcel.
- Loading docks, outside storage and service areas should be located out of sight from street like the side or the rear of buildings.
- Screening elements (minimum 6-feet, and maximum height of 10-feet) should be appropriately used to hide refuse, storage and equipment areas (Figure 2-3). Equipment may exceed the height of the screening elements by no more than 12 feet (12').



Figure 2-1: Distinguished Crosswalk



Figure 2-2: Roof Equipment Well Screened



Figure 2-3: Side Equipment Well Screened

4. Outside storage of any kind is not permitted in public street rights of way and building setbacks.
5. All screening materials should resemble the architectural elements of the building.
6. Impervious materials such as asphalt or concrete are recommended for paving the service and refuse areas and designed in accordance with the required fire access, and fire lane requirements.
7. Use sign and light to clearly identify service entrances.
8. Service roof ladders should be designed to be compatible with the architectural design of the building, and should not be mounted to the front building elevation.

## 2.7 - Water Quality Control and Drainage

The industrial site should drain adequately to off-site collectors without interfering with adjacent properties. All cultivation projects will be built with drains designed to capture and clarify discharge waters and re-use on-site.

1. All components of the roof drainage system such as drain and scuppers should be considered as an integral part of the architecture of the building.
2. Locate scupper and other devices used to convey rainwater at the base of a building.
3. Minimize water collection near building foundations, entrances and service ramps through proper design strategies.
4. Natural drainage patterns of the site should be retained and extended as much as possible.
5. Remove debris and potentially toxic substances found in non-point source runoff by considering landscape materials in stormwater retention basins.

6. To help in reducing stormwater runoff and filtering possible pollutants, incorporating bio-swales into landscaped areas at side and rear property lines strongly recommended (Figure 2-4 & 5).
7. Permeable paving is encouraged to be used for parking stalls (pavers, permeable concrete, etc).

## 2.8 - Site Grading, Excavation and Erosion Control

To enhance the architecture, screen nuisances and help provide for the privacy of adjoining uses, site grading should be considered as an important strategy.

1. Preserve the natural setting with grading designs that are sensitive to existing land form and topography.
2. All site infrastructure shall comply with all construction or industrial Storm Water Pollution Prevention Plans (SWPPP) that may be in place for the project developer; Coachillin' Holdings, LLC.

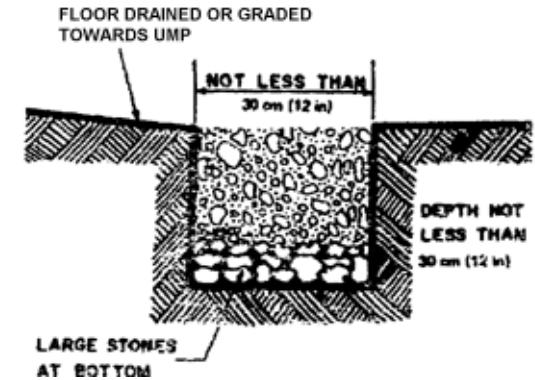


Figure 2-4: Bio-Swale General Detail



Figure 2-5: Stormwater Bio-Swale Landscaping & Planting

## CHAPTER 3

# VEHICULAR CIRCULATION, PARKING and LOADING



## Chapter 3 - VEHICULAR CIRCULATION, PARKING AND LOADING AREA

The industrial site should be well reached by freeways, arterials, adequate collector street systems, and pedestrian access systems. Likewise, the site internal circulation should provide adequate entrances, exits, loading facilities, and well-placed parking.

### GUIDELINES

#### 3.1 - Site Access and Vehicular Circulation

##### 3.1.1 Site Access

Site access should be clearly visible, well-designed, and consistent with the architectural character of the main structure.

1. Each property should have just one access point. A single point of shared entry to two abutting properties is preferred.
2. Entry drives from the internal service road should lead directly to building entrances.
3. Loading and parking access might be the same.
4. No drop curb openings can be located within 10 feet of the side property line. Shared access is excepted.
5. A minimum 100 feet interval between driveways may be considered.
6. A minimum 50 feet interval between access point to a site and a street intersection should be measured.
7. Site entries should be distinguished by high quality entry design features.
8. Using accent pavement materials located within the public right-of-way is encouraged.

9. Entries should be clearly marked with signage and significant landscaping.

##### 3.1.2 Vehicular Circulation

Vehicular circulation shall provide for the smooth, safe, convenient and functional movement of all modes of transportation, including vehicles, public transit, pedestrians.

1. Internal circulation should be clear and understandable.
2. Vehicular and pedestrian circulation systems should be clearly and safely separated.
3. The circulation system of industrial sites should be designed to reduce conflicts between loading trucks and other types of vehicular traffic.
4. Adequate space for vehicle maneuvering, including sufficient turning radii for large trucks should be considered and provided.
5. On all parcels located on the corners, AASHTO sight visibility triangles should be considered in design stage (Figure 3-1).
6. Visitor and employee circulation should be well-defined. Arrival and parking areas should be clearly separated from the recreational functions such as dispensary, restaurants, and commercial building.

#### 3.2 - Parking Lot Design

While adequate number of public parking in the whole project should be provided, parking lots and cars should not be the dominant visual elements of each site. Each property is expected to provide enough space to achieve its parking demand including use of internal streets. Parking can be integrated with landscaped setbacks.

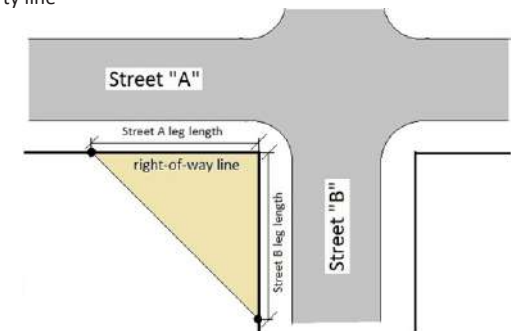
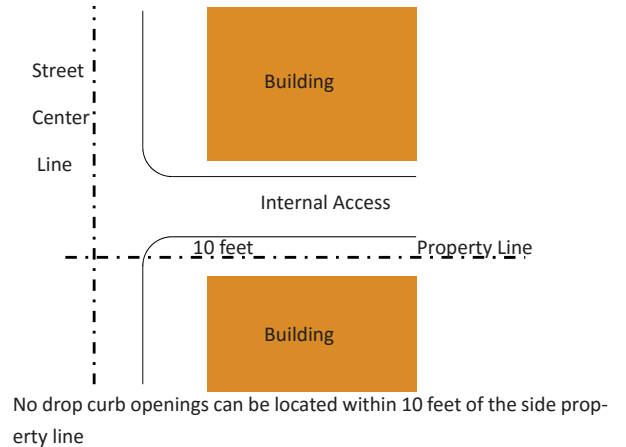


Figure 3-1: AASHTO Sight Visibility Triangles

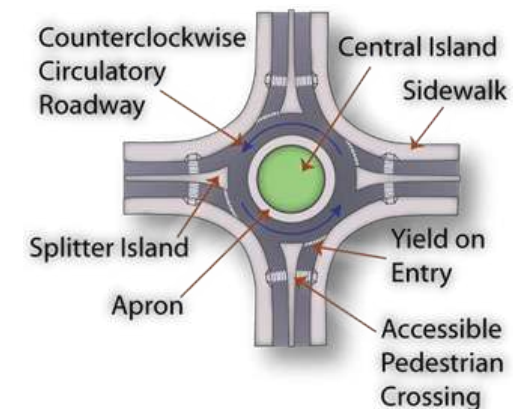


Figure 3-2: Roundabout Major Components

1. Parking lots that are visible from public streets should be screened from view; using rolling earth berms, low screen walls, and landscaping or combinations thereof (Figure 3-3).
2. Large, barren parking areas should be avoided. Minimize the size of parking.
3. In case of using the complete GFA, the owner must provide all demanded parking spots inside the building.
4. A parking area for 125 vehicles and more should be divided into a series of smaller, connected lots (Figure 3-4), exception being Parcel 25, which is designated for Industrial Energy & Community Parking.
5. Shared parking facilities with adjacent parcels is encouraged. Street parking in front of parcels is allowed.
6. Separate service vehicles from visitor and staff parking areas.
7. Avoid aligning all travel lanes in public parking lots in long straight configurations.
8. Sufficient space should be provided to allow vehicle stacking on-site. Parking areas should be designed to avoid vehicle stacking onto adjacent roadways.
9. A portion of the vehicle (2-feet) is permitted to hang over into a landscape strip (Figure 3-5).
10. Each standard parking space located perpendicular to the access drive shall have a minimum width of nine (9') feet and a minimum depth of nineteen (19') feet.
11. An appropriate number of accessible parking spaces shall be provided on the building site as required by applicable code and regulations. Each parcel may also allocate additional parking to Parcel #25 Community Parking area as needed to

meet code & regulations (allocations to community parking area shall not exceed 5% of the building site's required spaces).

12. The minimum number of parking spaces required per parcel is based on the following ratios (#Parking Spaces/Gross Building Floor Area based on section 17.48.040 of the City's zoning code requires):

- Retail space 1 space/250 SF
- Manufacturing, Research and Development, and Indoor Garden 1 space/500 SF
- Outdoor Display 1 space/2,500 SF
- Restaurant 1 space/75 SF (Excluding Outdoor Dining areas)
- Fast Food 1 space/100 SF
- Cultivation & Lab areas established by the Specific Plan: 1 space/2,500 SF (1:2,500) for Cultivation, and 1 space/750 SF (1:750) for Laboratory areas.
- Hotel: 1:1 space for each bedroom, plus requirements for related commercial uses, plus 1 space for each 50 SF of gross floor area of main assembly room, plus 2 spaces for manager's unit. For facilities visible from any freeway, on-site parking for "big rigs" shall be determined at project review.
- Events Parking (see events parking plan exhibit referenced in the Specific Plan Appendix 10.10).

13. All rows of parking should be ended by landscaped islands.
14. Trees and shrubs in the parking area help reduce surface heating, enhancing appearance and protect pedestrians from the elements.



Figure 3-3: Using Rolling Earth Berms To Screen Parking Lot



Figure 3-4: Well-Divided Parking Lot

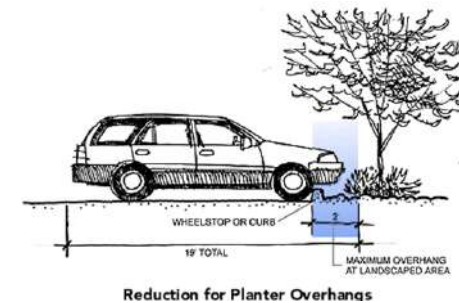


Figure 3-5: Vehicle Hang Over Into a Landscape Strip

15. The visitor parking areas are as important as the corporate/market image in terms of its presentation.

### 3.3 - Parking Lot Location

1. Locate parking at the front, rear and/or side yard of the buildings in properties.
2. Each owner shall provide adequate off-street paved vehicle parking on the building site. Owners may factor on-street parking (for street areas in front of their parcel) into parking calculations. Owners may also allocate additional parking spaces to Parcel #25 Community Parking as needed to meet code & regulations (allocations to community parking area shall not exceed 5% of the building site's required spaces).
3. Locate parking at the front yard of the buildings in all public accessible properties such as commercial buildings, dispensaries, touring and educational use buildings, showrooms, restaurants and bars.
4. Intermittent solar-covered shared parking will be provided on parcel #25, and may be considered in parking calculations.

### 3.4 - Loading Area

All developments need to provide sufficient on-site loading facilities to accommodate site service activities. Shared access and loading area between adjacent developments is encouraged.

1. No loading areas in front yard setback are permitted.
2. Loading docks, outside storage, and service areas should be in less visible area from public streets, such as at the side or at the rear (non-street side) of buildings (Figure 3-6).

3. Use buildings, landscape elements, solid decorative fence (minimum of six (6') feet high screen wall constructed of the same materials and finishes as the main building), or a combination thereof, to screen loading areas from public view (Figure 3-7). Murals may be considered decorative screening (i.e. a mural on the side of a container or generator). All murals and artwork must be approved by the POA.
4. Combine loading docks and service areas between multiple sites.
5. It is not permitted to any development plan to keep more than half of the site for vehicular purposes including parking areas, driveways, ramps, and loading areas, at their final development stage.



Figure 3-6: Choosing The Less Visible Area To Locate Parking Lot



Figure 3-7: Loading Area



# CHAPTER 4

## ARCHITECTURAL DESIGN



## Chapter 4 - ARCHITECTURAL DESIGN

Buildings in an industrial site, usually, are not as attractive as other type of buildings from an architectural point of view. In most cases, all elements including the scale and mass of buildings, materials, colors, roof styles, door and window openings, and details are just responsive to functional demand of the building and its program.

Each building and its surrounding should be unique and memorable through its architecture. Good architecture shall respond to environmental responsibility, functionality, and be cost effective. The architecture guidelines intend to create a high quality, best practice, industrial estate with a strong sense of place for users and visitors.

### GUIDELINES

#### 4.1 - Building Relationships and Compatibility

Buildings should be appropriately scaled to their surroundings to present a pleasing visual experience. Chaotic image of the site shall be prevented by adhering to the design guidelines.

1. Using architectural style, materials, colors, form and scale to unify the building, while each building on a single site should relate to other buildings on the same site in terms of their design and architectural style.
2. Building sides should be considered as an integral part of unified architectural style: materials, colors, forms and architectural details should be maintained for all portions of a building.
3. It is encouraged for adjacent sites to incorporate and minimize view of truck parking and loading areas, outside storage areas, ground mounted mechanical equipment, as well as trash and service enclosures from public paths.

4. It should be considered that new buildings are compatible in scale, massing, style, and/or architectural materials with existing structures in the project.

#### 4.2 - Building Height

The height of a building in each property, should be varied depending on the programs and purposes. Having a simple box building with a long lean roof line should be avoided.

1. Creative use of sloping roofs, modulated building heights, setbacks, innovative architectural solutions or combinations thereof to design varied roof lines is encouraged.
2. Different functions such as offices, warehousing, or general industrial should be defined better through varied building heights, setbacks and massing.
3. The maximum building height is 65-feet to the top of the building.
4. The maximum building height adjacent to public streets (e.g. Indian Canyon Drive, 18th, 19th, and Calle De Los Romos), is 55-feet to the top of the building.

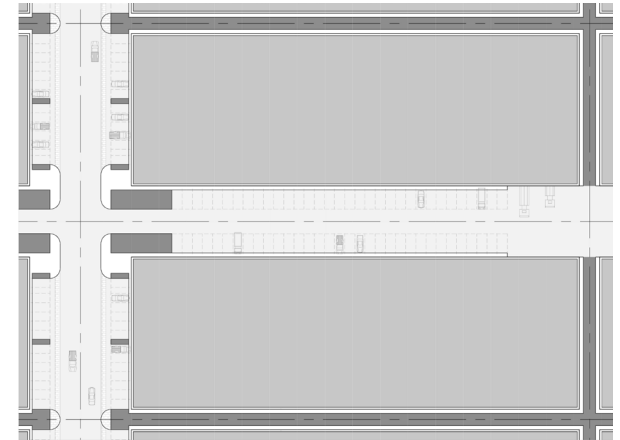
#### 4.3 - Building Massing, Forms, and Pedestrian Scale

Considering visual interest in buildings at the scale of the pedestrian, is a value. Reducing building apparent mass by creative use of setbacks regulations and other design guidelines. Simple square box structures with large, blank, unarticulated wall surfaces should be avoided (Figure 4-1).

1. Industrial systems and equipment should be considered as a design option; and creatively integrate into architectural design.



Figure 4-1: Visual Interest In Industrial Building



Shared Access (Appendix B)



Main Elevation (Appendix B)

2. Certain parts of the building such as entries and corners should be emphasized by correctly organized massing and forms.
3. Massing and architectural relief in the ground floor should be different from upper floors; to create visual interest and to moderate the perceived height of buildings.
4. Monumental and giant industrial and blank building is strongly discouraged.
5. Incorporate windows on ground floors help to improve the pedestrian experience, and create attractive and human scale space.
6. Minimize building bulk through integrating vertical and horizontal offsets within building facade.
7. Texture, color, material changes, shadow lines, and other facade elements of a building should be correctly used to break up the massive building size (Figure 4-2, 3).
8. Providing outdoor social spaces for employees is recommended. These may be provided on a landscaped, "green" roof area, or on any other landscaped area such as front yard setback.

#### 4.4 - Building Materials and Colors

Creative and appropriate use of materials can help avoid dull and repetitive facades; textures, colors, materials, and distinctive architectural treatments should be considered in this manner.

1. No more than three (3) kinds of materials should be used in one building facade; one of which will be the predominant material.
2. Preferred major exterior materials include brick, natural and artificial stone masonry, and/or architectural pre-cast panels such as:

- Factory glazed concrete masonry units
- Insulated glazing and framing systems
- Architectural pre-cast concrete
- Architectural metal as building accent only

3. Metal siding and preformed steel and aluminum panel systems shall be permitted upon review and approval by the Owner's Association.
4. Glass can be used on facades in a moderate way. No more than 20% outdoor reflectance for reflective glass should be used.
5. Using glossy metal is not recommended.
6. Bright colors, (including bright white) may streak, fade or generate glare.
7. Choosing a neutral overall color that respects the building's surroundings should be considered in building coloration (Figure 4-3).

#### 4.5 - Roof Forms and Materials

Rooftops are integrated parts of any building and should be considered as seen from other buildings.

1. Avoid large unrelieved expanses of wall or roof in architectural form and character.
2. Screen all fans, vents, cooling towers, skylights and any equipment located on the roof from the public view, to minimize their distraction from the architectural attractiveness (shall be set a minimum of a 10-feet from the building edge).
3. Use compatible materials, for screening, with materials and colors utilized on the building. Details of screening should be specified on the building drawings.



Figure 4-2: Appropriately Use of Design Tools to Break Up the Height



Figure 4-3: Appropriately Use of Color to Break Up the Height



Figure 4-4: White Material on Rooftops

4. Reflect heat away from buildings and increase the need for mechanical cooling by using white or reflective paint on rooftops and light paving materials (Figure 4-4).
5. Only standing seam or flat seam configuration metals are permitted for pitched roofs.
6. Pitched roofs colors shall be muted and compatible with the dominant building color.
7. Roof vents and stacks must be grouped.

#### 4.6 - Building Entrances

A building entry should be not only be clearly visible and identifiable, but also integrated within the overall building design and relate to human scale. Entry areas should provide the opportunity for outdoor amenities, such as planting and seating (Figure 4-5).

1. Provide a logical sequence of entry and arrival as part of the site's design.
2. Distinctive entryways help building to provide a transition between the street and the building with a better quality.
3. Entries can be framed by appropriate use of landscape elements.
4. Define, articulate and orient building entrances to pedestrians first, then vehicles in a very clear way. Front doors should always be facing the street and accessible from a public sidewalk.
5. Use overhead architectural features, such as awnings, canopies, trellises or cornice treatments to provide shade and reduce daytime heat gain at entrances and openings.
6. To enhance entries and guide pedestrians, designers should use special entry treatments such as stamped or colored concrete, special planting, signage,

columns, distinctive materials and colors (Figure 4-6&7).

7. Main entrances must be accessible to disabled persons without complex ramp systems.

#### 4.7 - Energy Conservation Measures

Building energy consumptions and water use must be reduced by choosing correct and innovative design strategy, and energy efficient equipment. Sustainability is a long-term response to this goal.

1. Applicants are encouraged to consider energy conserving design concepts, including, but not limited to the following:
  - Proper orientation and clustering of buildings to take advantage of the prevailing summer extreme sunlight and heat.
  - Types of material and their insulation characteristics.
  - The arrangement and design of windows and doors.
  - Direct solar or photo-voltaic energy.
  - Day-lighting concepts.
  - Natural ventilation of outdoor, indoor and attic spaces.
2. Always locate the air-conditioning in shaded areas to reduce heat loading.
3. All developments are recommended to incorporate high efficiency solar or gas Combined Cooling Heating & Power (CCHP) water heating systems (Figure 4-8).
4. Wind turbine and solar panels are encouraged where appropriate (Figure 4-9).



Figure 4-5: Outdoor Amenities at Entry Area



Figure 4-6: Distinctive Material and Form at Entry Area



Figure 4-7: Distinctive Material and Form at Entry Area

5. Using AAA rated fixtures such as shower heads, tap ware and flow regulators, and dual flush toilets. (4.5/3 Ltr)
6. It is encouraged to plant native and drought tolerant vegetation.
7. It is mandatory to use low flow trickle drip systems, or coarse sprays where necessary; and programmable controller/timer system, in case of water reticulation.
8. Using Bio- or Natural Gas powered Micro-turbines or Reciprocating Engines for Combined Cooling Heating & Power (CCHP) is recommended (Figures 4-10, 4-12, 4-13).



Figure 4-8: Solar Panel



Figure 4-9: Wind Turbine and Solar Panel



Figure 4-10: Biogas-Fired Microturbine Technology



Figure 4-11: Solar Carports, Electric Vehicle Chargers, Wind Turbines and Solar Panels



Figure 4-12: Building-Mounted Wind-Turbine



Figure 4-13: Rooftop Wind Turbine And Solar Panel Combination



# CHAPTER 5

## LANDSCAPE DESIGN



## Chapter 5 - LANDSCAPE DESIGN

Well designed landscape in an industrial site would act as a link to connect different building and uses to each other. Distinctive and innovative landscape would be achieved by considering architectural integration with the building, and choosing drought tolerant and native plants species in landscaping plans design.

Landscape elements such as trees, shrubbery, planter boxes, climbing plants, vines, green walls, or berms should be used to shade and screen, to emphasize specific points like entries, to contrast with or reinforce building design, to break up paving or wall expanses, and to define on-site circulation (Figure 5-1).

The Project's landscape design complies with the City's landscaping standards and accommodates the surrounding desert landscape. Cultivation & landscape irrigation water provided by a 750' on-site water Well and 4,000,000-gallon water storage reservoir and distribution system. Producing Date Trees along perimeter and in the retention basins for WQMP purposes along with desert scape will be the primary design theme.

### GUIDELINES

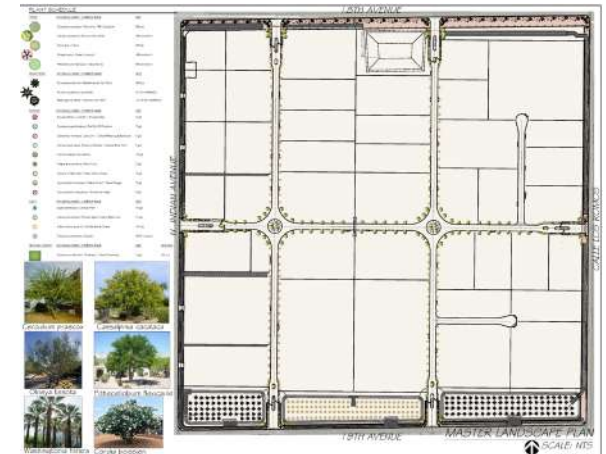
#### 5.1 - Landscape Standards and Plant Material Selection

Considering landscape design guidelines and hiring a qualified Landscape Architect would make the site comfortable and desirable. The site's landscape design complies with the City's landscaping standards and accommodates the surrounding desert landscape.

1. Landscaping is applied to all areas not covered by structures, service yards, walkways, driveways and parking spaces.
2. Landscape should be designed and plants should be selected to complement the architectural style and

form of the building, and as an integral part of the project (Figure 5-1).

3. All exposed sides, rear lot lines of site should be landscaped. The highest intensity of materials, including variety, concentration, and interest, should be located along a public street and the front or entrance to a building (Figure 5-2).
4. Provide summer shade on buildings, parking spaces, drives and paths by appropriate placement of landscape materials. Adequate shading reduces the amount of energy needed for cooling.
5. Landscaping and paved area should be balanced.
6. A good cohesive landscaping should:
  - Provide for a lush appearance
  - Be intense in its spacing
  - Consist of a variety of plant material
  - Display varied colors throughout the year
7. All loading, refuse, storage and equipment area should be screened with a combination of walls and landscaping.
8. Safe sight distances for vehicular, and pedestrian traffic should be considered in design stage and landscape materials planting.
9. To have an intensive image and better maintaining, landscaped areas should be at least five (5') feet wide.
10. Any type of artificial plants are not allowed as exterior landscaping within any parcel.
11. Plant materials selections from the Recommended Plant Materials List (Appendix D) are encouraged.



Site Landscape Plan (Appendix D)



Figure 5-1: Integrated Architectural Style And Landscape Design



Figure 5-2: Landscaping To Accent On Focal Points Like Entries

## 5.2 - Perimeter Landscaping Adjacent to Public Roads

Landscaping will be provided and maintained along the perimeter of the project site and throughout the site.

1. Use similar language in landscaping at all public entrances and intersections.
2. Public entries should be landscaped by placing perennial flower beds.
3. Adequate sight lines should be provided for an effective 30-foot sight triangle measured from the right of way. Plants are allowed within the sight triangle if do not exceed 30- inches in height at full maturity.
4. Each parcel should provide a minimum quantity of one (1) tree per twenty (20) linear feet of street frontage within the streetscape landscape setback area (Figure 5-3).
5. To avoid conflict with motorist visibility:
  - Trees' branches must be pruned up to a height of 8-feet
  - Plant shrubs a minimum of three (3') feet from the back of curb
  - Choose shrubs that do not exceed 24-inches mature height

## 5.3 - Perimeter Landscaping Adjacent to Abutting Property

Landscaped buffer can accomplish transitions between similar land uses and mitigate disarrangements between dissimilar uses.

## 5.4 - Building Site Landscaping

Internal parcels will be landscaped and maintained by each parcel owner.

1. In planting areas canopy trees, should be provided for shade and energy efficiency.
2. Landscaping can soften the edge between the parking lot and the structure.
3. Landscaping should be intensified at building entrances.
4. To keep cool west, south, and southwest sides of the building, use predominately deciduous trees adjacent to these elevations.
5. Use a combination of trees, hedges, shrubs and vines integrated to fences and walls along the street-facing side.
6. A minimum of five (5') feet width landscape band should be created along building side and rear elevations.
7. To aid in filtering pollutants and reducing storm water runoff, bio-swaales should be used in landscaped areas at side and rear property lines (Figure 5-4).

## 5.5 - Parking Lot Landscaping

Deciduous trees in parking lots and open area can help modify wind, heat, cold and moisture. Landscape planters are required in parking lots at an appropriate ratio (Figure 5-5).

1. Landscape plantings and grading should be effectively used to blend parking lots with each building sites' character, and can screen it from roadways (Figure 5-6).



Figure 5-3: Planting Trees On Street Frontage Of The Building



Figure 5-4: Bio-swaales



Figure 5-5: Deciduous Trees

2. Landscape areas, raised planters or trellises with vines should be used to separate pedestrian zones from parking and vehicle circulation.
3. Planting islands in a parking lot should function as bio-swales (minimum width of six (6') feet), to absorb and filter stormwater runoff (Figure 5-7).
4. Six (6') foot wide landscaped island should be provided at the end of every row of parking, equal in length to the parking space.
5. Place twelve (12') foot wide landscape medians between every other parking bay in lots for more than 125 cars to visually break large parking lots into smaller modules.
6. A minimum of one (1) tree per sixteen (16) spaces should be provided in parking lots.

### 5.6 - Planting Types and Size Standards

Plants and materials would include drought tolerant and native California species including trees, shrubs and ground-covers.

1. Mediterranean and other local climate-friendly plants may be used alongside native species.
2. Avoid using a few plants of many different species planted together. Use limited numbers of similar species in a group arrangement.
3. The plant palette within public easements should be relatively limited to shrubs, ground cover, and small ornamental trees.
4. Provide landscaping according to the following minimum sizes:
  - Deciduous shade/canopy trees 2.5 inch caliper
  - Ornamental trees 2.0 inch caliper

- Evergreen trees six (6') feet – eight (8') feet in height (minimum 25% must be eight (8') feet)
- Multi-Stem Ornamentals eight (8') feet – ten (10') feet in height
- Shrubs 5-gallon container
- Vines 1 gallon container
- Ground Cover/Perennials 2 ¼ foot pots

### 5.7 - Landscape Maintenance and Replacement

The property owner is responsible for providing, protecting and maintaining all landscaping in a healthy and growing condition.

1. Species that will require low maintenance in cutting and less watering (fescue sods are preferred) are encouraged to use where grass lawn areas are applied. Seasonal over-seeding is required.
2. All dead or diseased plant materials within each parcel shall be removed and replaced by the property owner.
3. Property owners are responsible for maintaining the abutting Landscape materials located in the public right-of-way.

### 5.8 - Site Furniture and Features

Shading of pedestrian areas in a hot summer climate like Desert Hot Spring is very important; trees or shade structures can provide shade along pedestrian walks and at parking areas (Figure 5-8).

1. In all site and landscape plans outdoor site amenities such as lighting, directional signs, patio areas, benches, planters, and trash receptacles should be included (Figure 5-9).



Figure 5-6: Landscaping And Mature Tree Reduce The Parking Lots Visual Impact



Figure 5-7: Bio-Swales Planting Islands In A Parking Lot



Figure 5-8: Shading Structure Helps To Reduce Heat On The Ground

2. All outdoor site furniture should be low maintenance.
3. Use landscaping and colored paving to reduce glare in open spaces.

### 5.9 - Landscape Irrigation/Water Conservation

To create and maintain suitable and sustainable landscape environment, and conserve water using automated, weather-based watering systems to water landscaped areas should be considered.

1. To reduce water consumption, planting drought tolerant species which requires little irrigation is strongly recommended.
2. Use advanced irrigation measures and scheduling. Efficient automatic irrigation system that will incorporate water conservation measures should be installed.
3. Reduce water demand by grouping plants with similar water requirements.
4. In areas of low visibility from public and private streets, non-irrigated native grasses should be planted (Figure 5-10).
5. Utilize drip irrigation where appropriate.
6. Grey water out of buildings, and discharge water (mixed with grey water) shall be captured properly and re-used in landscaping.



Figure 5-9: Benches As Landscape Amenity



Figure 5-10: Anza Borrego Spring Flowers

# CHAPTER 6

## FENCES and WALLS DESIGN



## Chapter 6 - FENCES AND WALLS DESIGN

All unsightly and displeasing views of heavy equipment, service yards and storage areas, from the public street must be screened. Walls or other screening devices should be carefully selected or designed as the permanent elements, which are integrated within the overall building design (Figure 6-1).

### GUIDELINES

#### 6.1 - Design and Materials

The colors, materials and appearance of walls and fences should be compatible with the architecture of the building. Walls and fences should be complemented with landscaping.

1. In general, avoid using fences along property lines that abut streets to screen the development. It is encouraged to avoid using fence or wall between properties as well. Using landscape elements to define the borders are strongly recommended.
2. All security fences, where required, must be set behind the required landscape buffer setbacks.
3. The height of the fence or wall depends on the degree of the security that the site needs, but it needs to be approved by the Owner's Association committee.
4. Change materials, color, or texture of long walls and fences to break it up to smaller portions.
5. Articulate architectural offsets and incorporate landscape pockets to fence or wall runs greater than 50 linear feet.

6. The use of barbed wire on any fence or wall is prohibited, except as approved by the Owner's Association committee. If approved, barbed wire must be on private property away from public view.
7. Scored or textured concrete walls, or faced with masonry or stone are permitted.
8. Wooden fences are generally not allowed on industrial Sites.
9. No chain-link fencing should be used in front yard, except during construction time.

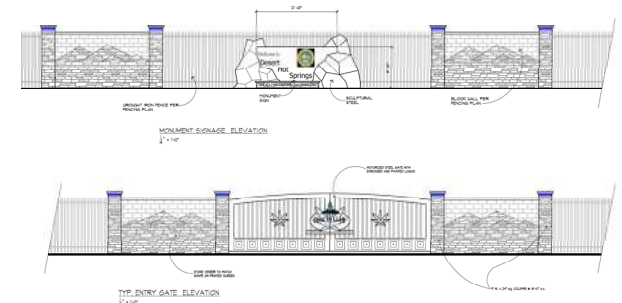
#### 6.2 - Screening Requirements

All types of mechanical equipment and utility, loading areas and service areas, and dumpster and garbage containers, should be properly screened by well-design walls and fences that integrated into the landscape and architecture (Figure 6-2).

1. All peripheral screening should be constructed of decorative masonry block or similar opaque material.
2. Visible screening devices from public area should be minimum of six (6') feet high constructed of the same materials and finishes as the main building.
3. Mechanical equipment (electrical, mechanical, plumbing, generators, cooling towers, etc.), As well as garbage and dumpster containers may be located within the building setback areas, provided they are properly screened per guidelines above.



Figure 6-1: Innovative Fence



Site External Fencing Elevations



Figure 6-2: Appropriately Equipment Screened



# CHAPTER 7

## SIGN DESIGN



## Chapter 7 - SIGN DESIGN

In this section the guideline for the design of signage and graphics within COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK will be established. Signage and graphics should be designed for a sense of continuity as an additional unifying element within the overall industrial and business center development.

The Project signage will consist of a combination of letter, logo signs and small projecting security oriented signs along with retail buildings that are architecturally integrated into the Project design.

**NOTE: THE ONLY SIGNS THAT SHALL BE ALLOWED TO DEVIATE FROM THE GUIDELINES SET FORTH BELOW ARE THE COACHILLIN' PARK "MONUMENT SIGNS".**

**DETAILS MAY BE FOUND IN SECTION 4 OF THE COACHILLIN' SPECIFIC PLAN DOCUMENT.**

### GUIDELINES

#### 7.1 - Sign Materials

All signs shall be of a size and nature to preserve the quality and atmosphere of the COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK.

1. Design signs which are intended to be attached to the buildings as an integrated part of the building.
2. Signs may not be of unusual size or shape, and should not contrast to the building it's attached to.
3. All signage should consider low energy consumption for lighting.
4. Back-lit acrylic or plastic "box" type signs are prohibited.
5. Individually cut letters with goose-neck lighting fixtures for direct illumination can be visible at a distance.

6. Signs should be simple and straightforward (Figure 7-1).

7. The maximum height of any free-standing sign will be eight (8') feet above grade (Figure 7-2).

#### 7.2 - Sign Number and Area

Limited numbers of sign which be located in appropriate areas, will help a business be seen better.

1. Each building site can only use two (2) signs that identifying user, nature of the business, and products.
2. All signs should be attached at ground level or on the face of the building.
3. No signs should be permitted to be raised above the roof line of a building or be located in front of a building setback line.
4. No sign shall be located in or painted on any window.
5. Freestanding, ground-mounted signs shall not exceed 50 square feet per face.
6. Surface-mounted signs shall not exceed 30 square feet of surface area each, nor exceed 80 square feet total per building.

#### 7.3 - Location/Placement/Visibility

Visibility without becoming a dominant part of the landscape or interfering with vehicular movement along the public streets, should be the policy for the location and placement of signage.

1. All signage for each building site shall be planned to be carefully integrated into the overall design (Figure 7-3).
2. Signs should be perfectly visible from streets and paths without conflicting with vehicular movement visibility.



Figure 7-1: Simple And Readable Ground Mounted Sign



Figure 7-2: Simple And Readable Ground Mounted Sign



Figure 7-3: Signage Integrated into the Landscape

3. No billboard or other advertising device nor any other signs shall be permitted within the COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK.

4. Signage should facilitate access to the building entrance with an appropriate height and size.

### 7.4 - Sign Illumination

Illumination of signage is permitted if the source of light is concealed.

1. Flashing, blinking, intermittent or moving light are not permitted as source of illumination.
2. For nighttime readability, signs should be illuminated to the minimum level.
3. Hide the light source from the 'lines of sight' of observers, when external light sources are directed at the sign surface (Figure 7-4).
4. Visible neon tubing is not allowed as a method of sign illumination.
5. Use ground-mounted metal halide fixture to illuminate monument signs.

### 7.5 - Allowable Sign Types

The Owner's Association of the Business Park should review and give permission prior to installation of any types of signs either temporary or permanent, whether free standing or affixed to any structure.

1. Monument Signs: Solidly built permanent signs.
2. Surface-mounted Signs on Buildings: Wall-mounted (Figure 7-5).
3. Projecting Signs are not permitted.

4. Pole-mounted Signs: Pole-mounted signs are just allowed for public use, and should be mounted and maintained by the Owner's Association.

5. Flashing or moving signs are not permitted.

### 7.6 - Special Entry Signs

These signs will be installed and maintained by COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK as a part of the common area of the project.

1. Entry signage is limited to monument or wall signage consistent with the architectural character of the buildings, with the address prominently displayed

### 7.7 - Building Identification Sign

Some businesses have their corporate identities that should be expressed properly in signage, while meeting the signage design guideline (Figure 7-6).

1. Identification signs should provide no more information than the name of the business and the identifying corporate symbol and colors.
2. The corporate identity or logo should not occupy more than 25% of the total area of the sign wall.
3. Just one identification sign shall be used for each building. An identification sign will be allowed within the setbacks if approved by the Owner's Association and surrounded by appropriate landscaping.

### 7.8 - Temporary Signs and Locations

Temporary signage, "super-graphics", real estate signage and so on are prohibited on the building, unless approved by the Owner's Association. Each parcel may have two signs designated for leasing or project construction identification, as applicable.



Figure 7-4: Hidden Light Source



Figure 7-5: Surface-Mounted Sign



Figure 7-6: Building Identification Sign

## 7.9 - Project Monument Signs

The Coachillin' Park will have three (3) monument signs placed in specific areas of the project. These two sign types will serve as monuments to the park as a whole, and shall be the only signs allowed to deviate from the sign program otherwise outlined herein the Coachillin' Design Guidelines. Consult Coachillin' Specific Plan for additional details for the exceptions granted for Project Monument signs.

1. Two (2) "Center Monument Signs" (as shown in Figure 7-7) will be located in the Southwest Corner (19th & Indian Canyon Drive) and Northwest Corner (18th Ave & Indian Canyon Drive) of the project.
2. One (1) Vertical Pylon Sign (as shown in figure 7-8) will be located at the main entry to the project (Coachillin' Way & Indian Canyon).
3. Details as to the makeup, composition, design, and locations of the three (3) monument signs may be found in the Coachillin' Specific Plan document.



Figure 7-7: "Center Monument Signs" rendering

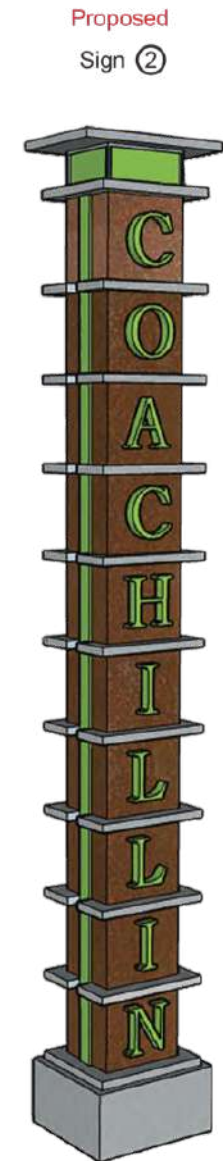


Figure 7-8: "Vertical Pylon Sign" rendering



# CHAPTER 8

## EXTERIOR SITE LIGHTING



## Chapter 8 - EXTERIOR SITE LIGHTING

Outdoor areas such as parking, shipping and receiving, pedestrian walkways, and work areas should be appropriately illuminated through wise lighting fixture placement. The overall use of site lighting will be designed as a unifying and aesthetic element in terms of lighting fixture style and lighting levels.

- Detailed lighting plan and specifications of electrical fixtures and fittings shall be provided to and approved by the Owner's Association committee.
- Increase energy efficiency through integrated solar powered lighting, induction lights, and LED lights.
- Outside lighting should improve the aesthetics of the site and the architectural qualities (Figure 8-1).
- No glare or light spill shall adversely impact adjoining properties.
- No glare or light spill shall impact passing motorists.
- Install lighting fixtures to accent and complement architectural details.

### GUIDELINES

#### 8.1 - Fixture Design

The light fixtures and their structural support should be architecturally compatible with the theme of the development, as well as energy efficient.

1. Select lighting fixtures, for interior or exterior, with consideration for energy conservation.
2. Avoid uneven light distribution, harsh shadows, and light spillage onto adjacent properties by utilizing adequate, uniform, and glare-free lighting, such as dark-sky compliant fixtures.

3. High-mounted, widely spaced pole fixtures that illuminate large areas from a single source should not be used.
4. The height of any fixture cannot exceed 35-feet.
5. Use photo-cell sensors and/or time clock control for external lighting.
6. Accent entrances and special architectural features by using appropriate exterior lights (Figure 8-2).
7. All pole-mounted fixtures shall be approved by the Owner's Association.
8. To minimize glare and spillage, light fixtures adjacent the site's perimeter and loading dock lighting will be shielded with an appropriate spill glare guard.
9. Ensure that lighting is shielded and directed towards the ground; minimizing light pollution of the night sky.

#### 8.2 - Parking Lot Lighting

Parking lot lighting should provide raised bases to avoid vehicle damage and irrigation spray, and provide safe light for orderly functions (Figure 8-3).

1. Use similar light fixtures for all surface parking areas.
2. Lighting in parking areas shall be limited to induction or LED lights.
3. Decorative accenting lighting and fixtures should be used at vehicle driveways, entry throats, pedestrian paths, plaza areas, and other activity areas.
4. Parking lot lighting standards should be placed so that the illumination spread will not conflict with the growth of trees in required parking lot planters.
5. All lighting devices that are located within planters, should provide raised bases that exceed the irrigation spray line.



Figure 8-1: Unifying and Aesthetic Lighting Elements



Figure 8-2: Using Appropriate Light Fixtures to Accent Entrances



Figure 8-3: Parking Lot Raised Bases

### 8.3 - Pedestrian Area Lighting

Within all development sites, architecturally integrated exterior lighting and directional signage should be used to provide safe and convenient pedestrian circulation (Figure 8-4, 8-5).

1. In the evening and at night, pedestrian lighting, should create safe, well-lit pedestrian areas.
2. For better identifying pedestrian walkways and drop-off areas at entrances to buildings, Bollard light fixtures or other low-level fixtures are encouraged.
3. Provide security by including after-hours lighting at building entrances.
4. Illuminate properly grade changes, steps, or other potential hazardous features along pedestrian circulation routes.
5. Incandescent, induction, or LED lamps are strongly encouraged.

### 8.4 - Site Security Lighting

Security lighting should not negatively impact the site and building architecture or adjacent parcels.

### 8.5 - Light Intensity

Using high-efficiency luminaries and bulbs, and maximizing user control, to minimize lighting energy demand.

1. Intensity should be no greater than required for automobile and pedestrian safety.
2. Exterior site lighting must be designed to minimize glare to adjacent properties or public streets (Figure 8-6).
4. To ensure adequate and appropriate light for each site condition, a photometric lighting plan should be provided to the Owner's Association.

### 8.6 - Performance and Amphitheater Lighting

Using high-efficiency luminaries and bulbs, and maximizing user control, to minimize lighting energy demand.

1. Lighting used to illuminate the amphitheater performance area must be either directed spotlighting or full cutoff lighting. If directed spotlighting is used, the light source must be located and designed such that it is not visible beyond the property boundaries
2. Lighting used to illuminate the amphitheater performance area shall only be turned on during performances or rehearsals
3. Lighting used to illuminate the signage, seating areas, pathways, and other areas of the amphitheater must meet all standards of the Specific Plan Design Guidelines and the City of Desert Hot Springs Municipal Code sections 17.140.140 and 17.140.170.



Figure 8-4: Pedestrian Lighting



Figure 8-5: Pedestrian Lighting



Figure 8-6: Appropriate Controlled Lighting Glare

# CHAPTER 9

## UNITY and SERVICE REQUIREMENT



## Chapter 9 - UTILITY AND SERVICE REQUIREMENTS

A Utility Plan, including connections to existing utility lines and proposed easements, must be submitted for each building site as part of the plan review process by the Owner's Association.

### GUIDELINES

#### 9.1 - Location of Lines and Connections

Exterior service equipment and utilities should be located where it can best integrate with the building's architecture, as well as have a good functional placement.

All off-grid power systems (natural gas engines, wind turbines, solar panels, etc.), must properly tie into site electricity, and be provided to the Property Owner's Association for review and approval.

1. All secondary utility lines should be located within side yards; under no circumstances, will a visible utility line be located within a front yard.
2. Locate noise and odor-generating functions so as not to create a nuisance for nearby residents or adjacent users.
3. Public safety, health and welfare should be considered in utility lines, connections and related functions design and construction.
4. While using Capstone/Natural Gas Generators, Solar and Wind Grid Tied, and Backup Generators are strongly recommended, noise, and pollution impacts should be reviewed and approved by experts.

#### 9.2 - Maintenance

All maintenance of the sites are the owner's responsibility.



Figure 9-1: Utility Maintenance



# CHAPTER 10

## ENERGY SYSTEMS and SUSTAINABLE DEVELOPMENT



## Chapter 10 - ENERGY SYSTEMS AND SUSTAINABLE DEVELOPMENT

Design considerations to sustainable developments, and to reduce dependence on the traditional energy sources for heating, lighting and cooling purposes are strongly encouraged.

### GUIDELINES

#### 10.1 - Site-Level & Shared Energy Systems

Consider opportunities to share energy, heating and cooling between site areas and with other parcels.

1. Any opportunities to pool backup generation systems with other buildings and parcels should be strongly considered.
2. It is encouraged to use some of the materials which have been manufactured from recycled or waste materials, in building construction.

#### 10.2 - Building Process, Heating & Cooling Systems

All equipment, including HVAC and process equipment, should be energy efficient.

1. Integrate HVAC systems with architectural strategies such as passive heating/cooling and natural ventilation, to minimize the required size.
2. It should be encouraged to factor a percentage of the building's energy cost to be obtained by purchasing Green Energy Certificates.
3. Use of envelope systems that facilitate the harvesting of energy, such as PV integrated cladding, or systems that capture solar heat are encouraged.
4. Photo-voltaic and solar water pre-heating are active solar energy systems that should be used.

5. Specify HVAC equipment that is designated as non-Hydrochlorofluorocarbon (HCFC) or low-HCFC.
6. NextAire or other Gas Chiller-Heat pumps are recommended to be used (Figure 10-1).
7. Use parabolic, solar concentrator, with sun tracker to supply heat for the absorption cooling or steam turbines are recommended (Figure 10-2).
8. Use of Geothermal Energy systems may be considered (Figure 10-3).

#### 10.3 - Building Lighting Systems

Depending on the type of industry, building lighting systems may differ; but in general:

- Take advantage of sunlight while minimizing unwanted heat gain in the summer, by using seasonal and/or user-controlled shading techniques.
- In order to use daylight efficiently, daylight harvesting systems such as Solatubes are recommended.

#### 10.4 - Refrigeration and Cooling System

The project uses non ozone-depleting refrigerants. It uses R407a for the refrigeration equipment. Refrigeration equipment is typically roof-mounted to the refrigerated cases. This reduces the amount of copper refrigerant piping, potential for leaks and refrigerant charge needed.

In refrigerated food area, LED's perform well in the cold, and produce less heat than fluorescent bulbs (heat which must be compensated for by the refrigeration equipment). LED technology is up to 52 percent more energy efficient than fluorescent lights.

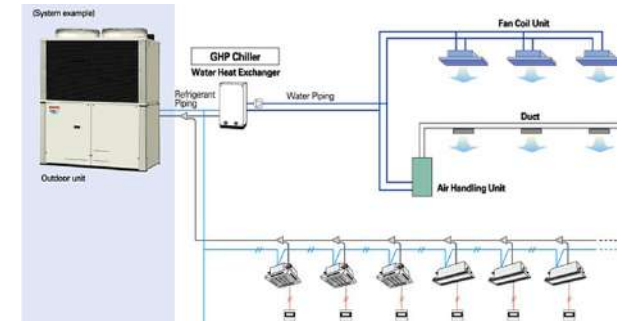


Figure 10-1: Gas Chiller-Heat Pump



Figure 10-2: Parabolic, Solar Concentrator System.

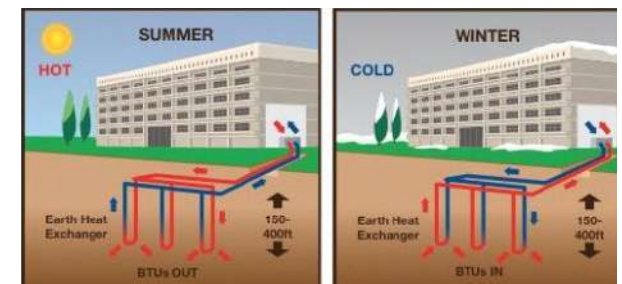


Figure 10-3: Geothermal Energy Concept



# CHAPTER 11

## WATER, STORMWATER and WASTEWATER SYSTEMS



## Chapter 11 - WATER, STORMWATER & WASTEWATER SYSTEMS

Minimize consumption of potable water, facilitate the reclamation and re-use of stormwater, and ensure wastewater treatment is managed properly.

Domestic water service to the project will be provided from Mission Springs Water District.

### GUIDELINES

#### 11.1 - Integrated Water Infrastructure Systems

Non-potable water sources should be considered as a source for using in industrial processes, wetland flow stabilization and, irrigation.

1. Non-potable water supplies can be served by roof runoff; if roof runoff storage and distribution are considered.
2. High quality clean water must be used just for drinking and some processes which require clean water sources, and lower quality water for other purposes e.g., vehicle washing, landscaping.
3. Double-plumbing is mandatory and should be considered in design stage as a strategy to provide a cost-effective opportunity to retrofit later with non-potable systems.
4. Additional savings can be realized by recovering waste engine heat for heating domestic hot water, and space heat process.

#### 11.2 - Stormwater

The Project will collect storm water into no-obstruction drainage pathways and street curbs to the South end basins. Overflow regional waters will be released in sheet flow fashion on the South Border exit waters will sheet flow the required pass-through volumes not retained on-site.

1. Manage all stormwater on site to ensure no runoff from the lots onto roads will occur.
2. Overland flow stormwater drainage and a natural, landscaped retention pond and/or a grassy swale system should be integrated into the site design.
3. Stormwater design should be integrated with landscaping. Stormwater retention basins should be considered as an amenity as well as a utility (Figure 11-1).
4. Avoid using concrete-lined channel; use a more natural approach that incorporates river rock or natural rock channel lining when possible.
5. Prevent stormwater runoff by using permeable or porous paving materials in lieu of concrete or asphalt, if it is possible.
6. Collect, store, and reuse stormwater for landscape irrigation.
7. 25% of the lot must be permeable, and can be achieved using the following types of strategies:
  - Landscaping areas
  - Porous driving surfaces
8. The stormwater management practice slows down and filters pollutants from runoff from the adjacent rooftops and driveway (Figure 11-2).
9. All landscaping and soil cover/stabilization shall be in place and meet construction SWPPP Termination requirements within 90 days of the completion of all construction activities. These minimum stabilization requirements shall be in place and maintained for a minimum of five (5) years.



Figure 11-1: Stormwater Retention Ponds



Figure 11-2: Bio-Swale Filters Pollutants from Runoff

### 11.3 - Wastewater System

The sanitary sewer system which the COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK intends to use is a temporary septic at one location, and the proposed Anaerobic Digestion (AD) system, with future hookups to the new Mission Springs Water District's plant.

Whether the system will be connected or not, it is mandatory to all owners to use a Small Bore Sewer system (SBS). The SBS is a watertight small diameter wastewater collection system designed specifically to contain and direct a predominantly solids-free liquid effluent by gravity through small diameter pipes managing grey water and solid material separately. The digester or clarifying tank is a decentralized primary wastewater treatment, methane capture and conversion facility and is required to be customized to each lot and development. The property owner will be responsible for operations and maintenance of the clarifying tank (Figure 11-3).

1. Wastewater clarifying tank (digester) is required for each lot and should be located with easy access for a vacuum service truck.
2. Wastewater from cultivation should be filtered to avoid discharging of toxic chemical contaminations such as phosphates, boron, chloroform, pesticides, nitrate to the park sanitary system. A cannabis wastewater reclamation system will be installed in retention basin #102.

### 11.4 - Water Efficiency

Using processing/manufacturing equipment that is water efficient, is highly recommended.

1. Re-circulate water, including collected stormwater or high-quality wastewater within industrial operations and between businesses, where it is possible.

2. The functionality of the pond shouldn't be impacted by landscaping in and around retention ponds.
3. For landscaping, consider xeriscape (a landscaping method requiring little or no irrigation or other maintenance) landscaping using native plant species.
4. Use high-efficiency fixtures and fittings including for example:
  - Dual-flush or 6 L per flush toilets
  - 3.8 lpm faucets
  - 5.7 lpm shower heads; and waterless urinals
5. Follow California urban water conservation council Best Management Practice (BMP) for water policies.

### 11.5 - Cultivation Water

Untreated cultivation water will be provided from well (#SWN 03S04E14C01S) and stored in reservoir (Parcel #14). Reverse Osmosis (RO) purified water will also be provided from an industrial RO plant located on Parcel #14.

### 11.6 - Grey Water

Discharge water from cultivation and grey water from buildings will be used for landscape irrigation.

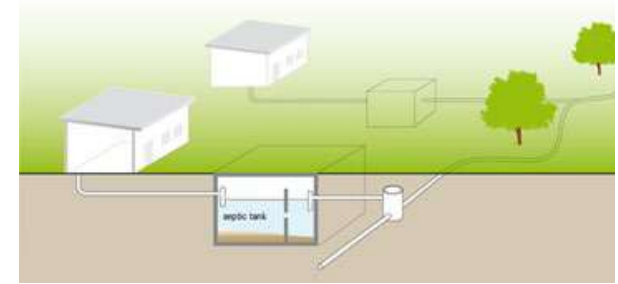


Figure 11-3: Small Bore Sewer System

# CHAPTER 12

## WASTE MANAGEMENT



## Chapter 12 - WASTE MANAGEMENT

Waste management is intended to reduce adverse effects of waste on health, the environment or aesthetics, and also use the waste as a new source of energy (Figure 12-1).

All of the plastic baseboards and much of the plastic shelving included in the expansion area will be composed of recycled plastic.

1. Use approved bin or container within an enclosed structure appropriately screened from view, to keep trash, garbage or waste material (Figure 12-2).
2. All trash, garbage and other waste materials shall be regularly removed from each building site.
3. It is encouraged to compact and recycle trash and should be accommodated in industrial project design.
4. Join both internal and external recycling stations to make recycling convenient.
5. All types of waste should be separated from the source:
  - Plastics
  - Green / Organic
  - Paper

### 12.1 - Vermiculture

The leftover organic waste produced by the anaerobic digester will be put into a Vermiculture / Red worm farm for further processing.

Worm composting, or Vermi-composting, involves the breakdown of food waste into a nutrient-rich compost through the action of worms and other microorganisms.

From this waste, the worms produce castings; a form of excretion that is incredibly nutrient rich and can be applied to gardens and farms. These castings have been referred to as “black gold” because of the value it can add to cultivation & food systems. The castings can be made into fertilization ‘teas’ that are perfect nutrition for cultivators growing within the Project.

For more detailed information see appendix H.

This facility will also contain an Aquaponics Grow Research and Development Grow Unit. Aquaponics is the combination of aquaculture (raising fish) and hydroponics (the soil-less growing of plants) that grows fish and plants together in one integrated system. The fish waste provides an organic food source for the plants, and the plants naturally filter the water for the fish. The third participants are microbes (nitrifying bacteria). These bacteria convert ammonia from the fish waste first into nitrites, and then into nitrates. Nitrates are the form of nitrogen that plants can uptake and use to grow. Solid fish waste is turned into vermi-compost that also acts as food for the plants. In combining both hydroponic and aquaculture systems, aquaponics capitalizes on their benefits, and eliminates the drawbacks of each.

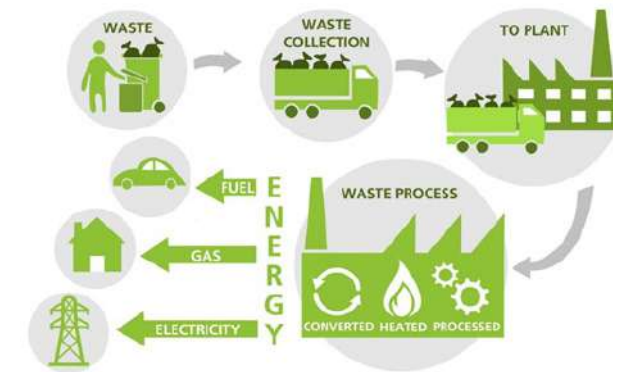


Figure 12-1: Cycle of Waste Management and Energy Production



Figure 12-2: Waste Container



# CHAPTER 13

## CONSTRUCTION



## Chapter 13 - CONSTRUCTION

A good and wisely designed planning and management plan, can minimize the negative impacts of construction.

### GUIDELINES

#### 13.1 - Construction Management

A good construction management plan shall be designed to achieve following goals:

- Minimize health impacts to construction personnel, and the adjacent areas
- Minimize site areas to be disturbed there by retaining natural vegetation
- Protect areas of natural vegetation from damage by fencing them
- Minimize construction truck traffic
- Minimize noise disturbance

#### 13.2 - Construction Schedule

All types of construction, renovation or new construction need “Construction Schedule” that must be provided and approved by the Owner’s Association committee before being started.

#### 13.3 - Construction Waste Management

Recycling strategies should be the priority to any waste management plan; minimize resource waste by engaging a waste management company. Project will consult City Franchise Agreement for additional details.

Coachillin’ will work with a waste management company to fully research all available Construction & Demolition (C&D) debris recycling facilities in the area, and its C&D program will seek to include the widest possible range of materials recovery options.

Waste management strategy should:

1. Minimize waste
2. Separate waste materials for recycling
3. Dealing with hazardous materials and wastes
4. Minimize health impacts of indoor air quality
5. Minimize disturbance of site area

#### 13.4 - Construction Environmental Guideline (Air & Water Quality, Sediment & Dust Control)

All types of construction, building and infrastructure, are costly to build and maintain, and impact to their immediate environment and beyond directly and indirectly. By following the guidelines and standards, construction can be pro-actively managed to reduce costs and environmental impacts.

All erosion, sediment, dust, and waste management controls must be, at a minimum, in compliance with the Construction SWPPP requirements described in the latest amended version(s) of the Project developer’s (Coachillin’ Holdings, LLC) SWPPP.



Figure 13-1



Figure 13-2



# CHAPTER 14

## MAINTENANCE



## Chapter 14 - MAINTENANCE

Shared elements/facilities maintenance will be planned and executed by the Park management. Shared elements include, but are not limited to the following:

- Cultivation Well
- Water Storage and Distribution
- Helipad
- WQMP Basins
- Volume Reduction Basins & Drainage Channels
- Public Sewer and Storm Network
- Public Landscaped Area
- Main Roads
- Perimeter Walls, Fences, and Gates
- Main Power and Lighting System
- Security Elements (Cameras, Observatory, Security Operations Center, & Security Personnel Bunkhouse)
- Private Infrastructure Elements including CO2 (storage & distribution), Hot BTU lines, Cold BTU lines, Cultivation Ag Water & Reverse Osmosis Water Purification System (storage & distribution).



# CHAPTER 15

## SECURITY



## Chapter 15 - SECURITY

Security guard protection on a cultivation site is not a matter of choice, it's a necessity. But to ensure smooth functionality and the safety of people working within the Project, hiring a team of highly-trained security personnel is as important as other key security elements. The key point in security plan relates to the balance between general image of the industrial site and reliable security.

The COACHILLIN' HOLDINGS, LLC Security and Control Plan ("Plan") details all-encompassing security provisions that cover COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK tenants and their products - from cultivation, production, packaging, labeling, tracking and transportation to distribution to the licensed dispensaries (Appendix E).

Owners must submit their parcel designs including architectural and landscape design and security plan to Property Owner's Association to be reviewed by Coachillin' Technology (CTECH) Security Management for design input and approval.

Coachillin' Technology LLC or its designated providers shall provide security surveillance system for the entire project in a unified platform to aid Security Personnel in monitoring the site from a single platform. Coachillin' Technology LLC shall also offer access control hardware and software, in addition, to individual parcel owners and/or tenants. All Security Plans must be approved by the Property Owners Association prior to implementation. For additional details, please reference the Owners Association CC&R's and Bylaws.

### GUIDELINES

#### 15.1 - Security Elements

Security devices that are attached to a building such as wall and fence should be compatible with

the architecture of the building. Lighting should be considered and planned as security elements, but not overly bright.

1. All areas within the Business Park, should be accessible to police and security staff.
2. All types of security fencing need to be provided to the Owner's Association as a general security plan and drawing details of fences.
3. Security elements should be less visible where it is possible, and integrated to architecture.
4. Front yard fencing to any public street frontage should be limited to a minimum and be within the theme of the business park and the proposed built form.

\*\*Reference the Coachillin' Project Security Plan included in the Coachillin' Specific Plan for more details.



Figure 15-1



# CHAPTER 16

## COACHING IN MANUFACTURING/PROCESSING

# Chapter 16 - COACHILLIN' MANUFACTURING, PROCESSING, & TESTING GUIDELINES

## 16.1 BACKGROUND

The COACHILLIN' INDUSTRIAL CULTIVATION & ANCILLARY CANNA-BUSINESS PARK is intended to update the existing entitlements to reflect current conditions and respond to changing market conditions relative to future development in the Project area.

The Plan's objectives provide for the successful, responsive and valuable development in a manner consistent with the City of Desert Hot Springs General Plan and other applicable planning documents. This Plan meets all requirements of California Planning Law and represents the results of a collaborative planning effort by the City, property owners, designers, environmental consultants and service agencies.

## 16.2 DEFINITIONS

**"Active Ingredients"** means, in the case of dried cannabis flowers, extractions or infusions, delta-9-tetrahydrocannabinolic acid, delta-9-tetrahydrocannabinol, cannabidiolic acid, cannabidiol, and any cannabinoid or propyl cannabinoid derivative when present in amounts greater than .5% by dry weight, and any mono- or sesquiterpenoid present in an amount exceeding .3% of a product's dry weight.

**"Cultivate" and "Cultivation"** mean activities related to the growing, harvesting, drying, curing, processing, manicuring and production of cannabis, and may include testing, manufacturing and preparation of edibles, as long as the predominant use is cultivation of cannabis.

**"Harvest Batch"** means a specifically identified quantity of processed cannabis that is uniform in strain, cultivated using the same herbicides, pesticides, and fungicides, and harvested at the same time.

**"Cannabis By-Products"** means delta-8-THC and cannabidiol (CBD) when present in amounts greater than .2% of a product's dry weight.

**"Dispensary"** means a facility whose purpose is to dispense cannabis products to the consumer.

**"Extraction"** means a process to remove the cannabinoids and other components from plant material.

**"Manufacturing"** means any activity involving the production, preparation, propagation, or compounding of raw cannabis into a concentrate, an edible product, or a topical product, directly or indirectly, by extraction methods, independently by means of chemical synthesis, or by a combination of extraction and chemical synthesis.

**"Marijuana Facility"** means a location which can cultivate, manufacture or dispense cannabis and cannabis products and/or any of the activities described in this definition.

**"Production Batch"** means a group of Cannabis-Infused Product created from a production run of cannabis product.

## 16.3 ALLOWABLE EXTRACTION LABS AND FACILITIES

Coachillin Holdings LLC ("CHL" or "Coachillin") will allow only Class 1, Division 1, Extraction Labs to operate on its premises. By definition, Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

**Class I, Division 1:** There are three (3) different situations that could exist to classify an area as a Class I, Division 1 location:

1. Ignitable concentrations of flammable gases or vapors may exist under normal operating conditions.
2. Ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage.
3. Breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

## Ventilation

**Air changes.** Laboratory activities involving work with toxic, flammable, or irritating materials must be provided with adequate ventilation. This is necessary to provide supplemental air for the fume hoods and to provide clean air for breathing. The ventilation system should be capable of independently providing 4-12 air changes per hour with 100 percent exhaust. Other types of laboratories may require additional ventilation.

**Intake and exhaust.** Intake and exhaust ventilation should be balanced to maintain a slight negative pressure with respect to adjacent areas to ensure that air movement is into the laboratory. Air must be exhausted outdoors and not recycled. Exhaust discharges must not be located near air intakes of buildings.

All extraction labs must be properly ventilated to ensure the safety of all employees. Ventilation systems should meet requirements set forth by local Fire Code.

## Explosion Proof Storage Cabinets

Flammable liquids must be stored in flammable storage cabinets, approved safety cans, or a properly designed flammable storage room. Approved storage cabinets are

designed to protect flammable liquids from involvement in an external fire for ten (10) minutes. This is the time it would normally take for an area to become seriously involved in a fire.

**Approval.** All cabinets must comply with OSHA and NFPA requirements.

**Fire resistance.** Cabinets must be capable of limiting the internal temperature to less than 325° F when subjected to a 10-minute standard fire test.

**Metal cabinets.** The bottom, top, door, and sides of metal cabinets shall be constructed of at least No. 18 gage sheet iron, and double walled with one and a half inch air space. The door sill shall be raised at least two (2) inches above the bottom of the cabinet.

**Wooden cabinets.** The bottom, top, and sides of wooden cabinets shall be constructed of at least one (1) inch thick high density plywood. When more than one door is used, there shall be a rabbeted overlap of not less than one (1) inch. Hinges shall be mounted so that they will not loosen during the fire test. The door sill shall be raised at least 2 inches above the bottom of the cabinet.

**Storage limits.** Maximum storage limits for flammable liquids in approved storage cabinets are 120 gallons of Class I, Class II, and Class IIIA liquids. Of this total, only 50 gallons of Class I and Class II liquids are allowed. No more than three (3) such cabinets may be stored in a fire area.

**Venting.** Storage cabinets are not required to be vented unless required by the local Fire Marshal. Venting a cabinet may defeat the cabinet's purpose of protecting the contents from involvement in a fire for 10 minutes.

**Labeling.** Cabinets must be labeled in conspicuous lettering «Flammable-Keep Fire Away.»

## Safety Transportation Cans

Portable approved safety cans can be used to safely store, carry, and pour flammable and combustible liquids. The main purpose of the safety can is to prevent an explosion of the container when it is heated. Safety cans are constructed of terne plate steel, stainless steel, or high density polyethylene. The type of can purchased is determined by the chemical properties of the flammable liquid and how it will be used. Terne-plate steel cans are designed to store petroleum solvents if the purity and color of the solvents are not critical. Some solvents may also dissolve the paint from the outside of these cans. Stainless steel cans are recommended when high purity solvents are needed. High density polyethylene cans are resistant to many solvents but may cause discoloration of the solvent.

**Approval.** Safety cans must be UL listed and FM approved, and properly labeled to identify contents.

**Construction.** All approved cans must have a lid that is spring loaded to close automatically after filling or pouring. The lid also acts as a relief valve when pressure builds up. A flame arrestor screen must be inside the cap spout to prevent fire flashback into the can.

## 16.4 SOLVENT USAGE

Manufacturers who hold a Type 7 license that was obtained by the Department of Public Health (DPH) may use the hydrocarbons N-butane, isobutene, propane, or heptane or other solvents or gases exhibiting low to minimal potential human health-related toxicity approved by the DPH. These solvents must be of at least ninety-nine percent purity and a processor must use them in a professional grade closed loop extraction system designed to recover the solvents, work in a Class 1 Division 1 laboratory environment with proper ventilation, controlling all sources of ignition where a flammable atmosphere is or may be present.

The explosive characteristics of the air mixtures of gases, vapors, or dusts vary with the specific material involved. Materials have been placed in groups based on their ignition temperatures and explosion pressures. Class I and Class II Divisions are further subdivided into Groups of hazardous materials. The Groups define substances by rating their flammable nature in relation to other known substances.

Combustible and flammable gases and vapors are divided into four Groups. The classification is based on maximum explosion pressures, and maximum safe clearance between parts of a clamped joint in an enclosure per NEC section 500-5(a)(4) FPN No. 2.

The table below provides examples of which materials actually make up specific Groups.

| Class   | Division       | Group | Flammable Material   | Maximum Experimental Safe Gap (MESG) | Minimum Igniting Current Ratio (MIC) |
|---------|----------------|-------|--|--------------------------------------|--------------------------------------|
| Class I | Division 1 & 2 | A     | Acetylene  | —                                    | —                                    |
| Class I | Division 1 & 2 | B     | <ul style="list-style-type: none"> <li>• Hydrogen</li> <li>• Butadiene</li> <li>• Ethylene Oxide</li> <li>• Propylene Oxide</li> </ul>   | 0.4mm                                | 0.4                                  |
| Class I | Division 1 & 2 | C     | <ul style="list-style-type: none"> <li>• Ethylene</li> <li>• Cyclopropane</li> <li>• Ethyl Ether</li> </ul>  | > 0.45 mm    0.75 mm                 | > 0.4    0.8                         |
| Class I | Division 1 & 2 | D     | <ul style="list-style-type: none"> <li>• Propane</li> <li>• Acetone</li> <li>• Ammonia</li> <li>• Benzene</li> <li>• Butane</li> <li>• Ethanol</li> <li>• Gasoline</li> <li>• Methanol</li> <li>• Natural Gas</li> </ul> |                                      |                                      |

At the current time, Coachillin' will allow the use of food grade propylene glycol and vegetable glycerin as additives since the U.S. Food and Drug Administration (FDA) consider them as safe applications for human consumption.

Vegetable Glycerin is an all-natural liquid, generally extracted from plant oils, in particular, soy, coconut oil, and palm oil. It is typically clear with little hint of color, odorless, in some cases sweet, and relatively viscous. Like Propylene Glycol (PG) it is considered safe by the FDA. The main applications of Vegetable Glycerin are cosmetics products, food production, and e-juice.

Propylene Glycol (PG) is an organic compound produced from Propylene Oxide. It is colorless, nearly odorless, and retains low viscosity. Food grade Propylene Glycol is recognized safe by the U.S. Food and Drug Administration. The main applications for Propylene Glycol are solvents, humectants, preservatives in food, tobacco products, pharmaceutical products, and of course e-juice.

Both Propylene Glycol (PG) and Vegetable Glycerin (VG) are considered safe and acceptable substance to be ingested by the U.S. Food and Drug Administration. In fact both substances are part of many types of food, pharmaceutical and cosmetic products. That said, there are rare cases of minor allergic reaction to Propylene Glycol (PG). Typical allergic reaction consists of skin irritation or rash, and/or minor throat inflammation. In most cases people who are allergic to Propylene Glycol (PG) already know that since it is used in many foods and day-to-day products.

The use of Class I (i.e. Carbon tetrachloride and 1-1, dichloroethene and 1-2 dichloroethane) and Class II (i.e., Hexane, xylene, chloroform) solvents is strictly prohibited. Class I solvents are those to be avoided because they are strongly suggested to be a carcinogen or are an environmental hazard. Class II solvents should be avoided due to potential neurotoxicity or teratogenicity.

## 16.5 EXTRACTION AND POST PROCESSING EQUIPMENT

Based on the Class 1, Division 1 classification, all equipment used in the facility must be rated to be used in a Class 1, Division 1 Laboratory. This includes, but is not limited to all pumps, lighting, power and other electrical equipment located in the space. Extraction support systems such as air compressors, fluid circulation pumps, etc. may be located outside the Class 1, Division 1 classification area and may be piped to the Lab area where it is needed. All electrical systems must be grounded and separated to minimize the risk of spark by static charge.

### Extraction Types and Equipment

Only closed loop extraction types are allowed on Coachillin Holdings Premises. Open extraction systems are strictly prohibited. All equipment used must meet local Fire Code. All equipment must be used per the manufacturer's instructions and guidelines. All extraction equipment must be professionally installed, preferably by the manufacturer, and have an installation certification available. Other extraction types that utilize heat, presses, steam distillation, ice water, screens and other solvent or gas free methods are also allowed with a Type 6 license issued from the DPH. Only trained and licensed personnel may operate equipment; documentation of training must be available upon request.

### Carbon Dioxide (CO<sub>2</sub>) Closed Loop Extraction

CO<sub>2</sub> Extraction uses the supercritical properties of carbon dioxides, pressure and temperature, to manipulate the physical state of carbon dioxide (liquid or gas forms) to selectively extract desired components from the cannabis plant.

CO<sub>2</sub> extraction equipment is required to have releases

of CO<sub>2</sub> piped to the exterior. Stored cylinders shall be secured to a fixed object to prevent falling.

A fixed continuous CO<sub>2</sub> detection system is required within CO<sub>2</sub> extraction rooms set to alarm at 5000 ppm. This system is a local alarm only and is not required to be monitored off site. The system is intended to alert the extraction operator of a potential asphyxiation hazard. There is no requirement to alarm the building nor to have ADA compliant visual notification as typically required for fire alarm systems.

### Hydrocarbon Closed Loop Extraction

Hydrocarbon Extraction uses a hydrocarbon solvent, such as isobutene, heptane, propane, butane as a solvent to extract cannabinoids from the cannabis plant. Any solvent or gas that presents minimal risk to human health related toxicity may be used. All solvents and gases must be at least ninety-nine (99%) percent purity. If possible, systems should be designed to recapture all solvents used in order to minimize waste and impact on the environment.

There are many different methods available to perform flammable liquid extractions as well as a variety of equipment available; therefore, all processes cannot be described in detail within this guideline. Generally, these processes can be grouped into two (2) categories; distillation extractions where most of the flammable solvent is recollected OR a heated boil-off (evaporative) process where flammable liquid is evaporated to the atmosphere without recollection.

A hazardous exhaust system is required, complying with IMC Section 510 for flammable liquid processes exceeding five (5) gallons. These typically include boil/evaporative processes, distillation processes, and flammable liquid plant wash processes. This exhaust system is intended for larger processes where dispensing of flammable liquids also occurs in greater volumes,

flammable liquid laden plant material is removed from equipment and/or vapors are present from heated extraction processes. The exhaust system must provide capture and containment velocity across the work area and is typically provided in the form of a standard lab-type exhaust hood. It is suggested that the ACGIH Industrial Ventilation Handbook be consulted for exhaust system and capture velocity design.

There are two forms of flammable gas detection required in LPG extraction areas: fixed continuous flammable gas detector serving the room, hood, or booth and a portable flammable gas detector. The intent of these types of flammable gas detection systems within LPG extraction areas is twofold: for alerting the extraction process operator(s) that the area is at or above 10% of the lower flammable limit and for the extraction process operator(s) to specifically identify potential leaks during the extraction and additionally to determine when oil and spent plant material is finished off-gassing and is safe to be removed from the extraction area.

The fixed detector must be installed in accordance with the manufacturers' guidelines and depending on the size and configuration of the room, booth, or hood, additional detectors may be required. The fixed detection alarm is a local alarm only and does not require off-site monitoring and does not require full occupant notification of the building or extraction room (including ADA visual notification) as a fire alarm system may require. Fixed detection is to alarm at 10% of the lower flammable limit. The method of alerting the extraction operator (audible / visual notification) is based on the type of the gas detector chosen. Some detectors have integrated visual alarms only that can be accepted when installed within clear view of the extraction operator; i.e. at eye-level with the sensor extended to the floor. Otherwise, a remote visual or audible local alarm can be accepted.

## Post Processing Equipment

Extraction processing equipment that uses hazardous or flammable solvents and gases, including that which is used for winterization, solvent removal, distillation and solvent removal must meet the requirements of local Fire Code. Only trained and licensed DPH personnel may operate equipment; documentation of training must be available upon request.

For the purposes of this section, exhaust system requirements for extraction processes using flammable liquids are also required for post-oil processing using flammable liquids. Post oil processing is an oil refining or winterization process occurring after the initial extraction is completed.

For rooms, booths, or hoods containing flammable liquid extraction or post oil processes, the electrical location classification must be specified by the responsible licensed design professional. It is expected that this classification is included on building permit drawings and that supporting information is submitted justifying how the location classification was determined. Because there are numerous methods of performing flammable liquid extractions, the process must be evaluated and the classification determination must be established by the licensed design professional. Note that the licensed design professional must consider not only the process equipment, but also the dispensing (i.e. filling and removal) of flammable liquids, soaking (i.e. plant wash) material in open containers, and the removal of plant material saturated with flammable liquids, because these operations may have an impact on the location classification.

## Refrigerators/Freezers

Refrigerated storage or processing areas may have confined vapors from flammable liquids which are easily ignited and represent a major hazard in laboratory

refrigeration units. There are a number of potential ignition sources in a normal refrigerator or freezer. Spark producing devices include the thermostat, light switch, defrost mechanism and compressor. In addition, self-defrosting units have a drain hole at the bottom. Vapors can escape through the hole and be ignited by the compressor.

**Standard refrigerators.** Because of the danger of fires and explosion, standard refrigerators and freezers may not be used for storage of flammable liquids. These refrigerators should be posted as unsafe for storage of flammable liquids.

**Acceptable units.** The following types of refrigerators are safe for the storage of flammable materials:

Explosion-Safe or flammable storage refrigerators and freezers, which have been modified to eliminate the spark producing mechanisms.

Explosion-Proof refrigerators and freezers, which not only protect against flammable vapors inside the unit, but may also be operated in rooms that have an explosive atmosphere. These units must be permanently wired to the laboratory electrical system.

The extra protection afforded by Explosion-Proof units is not necessary for solvent storage under ordinary laboratory conditions. Explosion-Safe units are recommended for this purpose. However, if large amounts of ether are stored, the former should be considered.

## Flammable Liquid Distillation and Evaporative Equipment

There are numerous methods to perform distillation or evaporative extraction / refinement processes. In general, electrified equipment used in these processes are required to be listed by a NRTL for their intended use and are required to be operated within the

manufacturer’s guidelines. Equipment such as rotary evaporators are typically listed for distillation processes. Where distillation stills or heated evaporation processes are performed, the heating source shall be listed as explosion-proof (i.e. rated for the electrically classified location) unless it can be shown that the equipment has been tested during its listing to heat flammable liquids without the explosion-proof classification. Approval of the proposed process equipment must be submitted during construction permitting review.

Distillation process using less than five (5) gallons are to be performed under a chemical fume hood designed to contain fumes within the hood and exhaust them to the exterior. This system does not have the duct gauge thickness and other requirements of a full hazardous exhaust system. This exhaust system is typically for smaller bench-top type of distillations and also small flammable liquid dispensing volumes.

### Vacuum Ovens

Vacuum ovens shall not be used to process volatile gases (i.e. alcohol/oil mixtures, oil containing off-gassing LPG, other flammable liquids, etc) unless the vacuum oven is rated to process these vapors (typically an explosion-proof classification). It is the responsibility of the extraction process operator to ensure the material being introduced into the oven do not contain volatiles.

When necessary to use a vacuum oven for the removal of flammable gases, only vacuum ovens rated to handle flammable gases may be used in processing cannabis products. These ovens usually have an explosion proof classification.

If the vacuum oven is not rated as explosion proof, the vacuum oven may not be used to process oil containing flammable gases or solvent. Only explosion proof rated vacuum ovens shall be used to process oil containing flammable gases or solvents. In this case, it is the responsibility of the operator to ensure that there are

no flammable gases present prior to using the vacuum oven

## 16.6 TESTING

All products produced to be dispensed will be required to be tested by an Independent, unrelated third party laboratory. These products include, but are not limited to: flower, oils, edibles, tinctures and topicals. Internal laboratory testing may be conducted; however, it does not satisfy the requirement for third party testing.

Products must be tested for the following: potency, residual solvents, terpenes, heavy metals, pesticides, microbials and molds. See below for a basic summary of testing requirements. See Operational Manual for more detail of testing required for each type of product. Tests other than those required may be performed. See Appendix 1 for more detail.

| Product                  | Potency | Microbials | Terpenes | Pesticides | Heavy Metals | Residual Solvents |
|--------------------------|---------|------------|----------|------------|--------------|-------------------|
| Flower (to be dispensed) | X       | X          | X        | X          | X            |                   |
| Concentrates             | X       |            | X        | X          | X            | X                 |
| Edibles                  | X       | X          |          |            |              |                   |
| Tinctures                | X       |            |          | X          | X            |                   |
| Topicals                 | X       |            |          |            |              |                   |

## 16.7 PACKAGING AND LABEL REQUIREMENTS

Medical Cannabis and Medical Cannabis Products that are made available to patients shall be contained in packaging that bears labels containing the following information, in addition to any other information that a Dispensary may choose to provide or that may be required by law:

### All Cannabis Products

1. "Cannabis Product, Contains THC".
2. Serving size
3. Product Weight
4. Directions for use
5. Potential health risks:
  - a. "There may be health risks associated with the consumption of this product."
  - b. "This product contains marijuana and its potency was tested."
  - c. "This product was produced without regulatory oversight for health, safety, or efficacy."
  - d. "The intoxicating effects of this product may be delayed by two (2) or more hours."
  - e. "There may be additional health risks associated with the consumption of this product for women who are pregnant, breastfeeding, or planning on becoming pregnant."
  - f. "Do not drive a motor vehicle or operate heavy machinery while using cannabis."

6. Test results, at a minimum:
  - a. Potency, % THC, %THCA, %CBDA, %CBD at a minimum
  - b. Microbials
7. All ingredients used during the production of the product
8. All non-organic pesticides, fungicides and herbicides used during cultivation
9. The date of manufacture or production
10. A complete list of all ingredients

### Edible Products

1. Preparation, Packaging and Labeling of Edibles.
  - a. Edibles. Edibles shall be limited to those items approved in the California Homemade Food Act, Chapter 6.1 (commencing with Section 51035) of Part 1 of Division 1 of Title 5 of the Government Code.
2. Compliance with State Food Safety Requirements. A Dispensary that prepares, dispenses, or in any manner distributes Edible Medical Cannabis Products must comply with the relevant provisions of all State and local laws specified by the City Manager regarding the preparation, distribution, labeling and sale of food, even if those laws are not directly applicable to Edibles. Any facility used by a Dispensary to produce Edibles shall be constructed, operated and inspected in accordance with the applicable building code and applicable food safety requirements.
3. Preparation of Edibles.
  - a. Individuals involved in the production or distribution of Edibles containing Medical

Cannabis shall thoroughly wash their hands before commencing production and putting on kitchen plastic food gloves before handling any food products. Gloves must also be worn when packaging edible products.

- b. In order to reduce the likelihood of food-borne disease transmission, individuals who are suffering from symptoms associated with acute gastrointestinal illness or are known to be infected with a communicable disease that is transmissible through foodstuffs are prohibited from preparing edible products containing Medical Cannabis until they are free of that illness or disease, or are incapable of transmitting the illness or disease through foodstuffs. Individuals who have sores or cuts on their hands must use gloves when preparing and handling edible products containing Medical Cannabis.
- c. Edibles that are produced or distributed at a Dispensary may only be prepared by a Member of that Dispensary and, if prepared in Berkeley, shall only be prepared in a facility permitted and inspected for the production of food by a government agency, such as a commercial kitchen or a facility operating in accordance with the California Homemade Food Act.
- d. Certified Food Handler. A Member who produces Edible Medical Cannabis Products must be a State certified food handler. The valid certificate number of such Members must be on record at each Dispensary where the edible product is distributed, and a copy of the certificate kept either on-site, or made available during inspections if kept off-site.
- e. Hand-washing Facilities. Hand-washing facilities shall be adequate and convenient and

be furnished with running water at a suitable temperature. Handwashing facilities shall be located in the facility in Edible preparation areas and where good sanitary practices require employees to wash and/or sanitize their hands, and provide effective hand-cleaning and sanitizing preparations and sanitary towel service or suitable drying devices.

#### 4. Packaging of Edibles.

- a. All Edibles shall be individually wrapped at the original point of preparation. Labeling shall be distinctly and clearly legible on the front of the package and must include: (i) a warning if nuts or other known allergens are used; (ii) a warning that the item is a medication containing Medical Cannabis and the total weight (in ounces or grams) and amount of Active Ingredients in the package; (iii) the date of manufacture; (iv) a statement that the contents are not a food product; and (v) information indicating any caloric impact on the patient. The package label must have a warning clearly legible emphasizing that the product is to be kept away from children.
- b. Labels of Edibles that are not tested for contaminants (baked goods) shall include a statement that the cannabis used in the product was tested for contaminants.
- c. Packaging of Edibles shall be opaque, and may not make it appear as if the Edible is a food product. Packaging that makes the product attractive to children or imitates candy is not allowed.
- d. Packaging of edibles shall be tamper-evident.

#### 5. Producers of Edibles that are not tested for contaminants shall maintain a written or

computerized log documenting:

- a. The source of the cannabis used in each batch of product;
- b. The contaminant testing date; and
- c. The testing facility for the cannabis

6. Scales and weighing mechanisms used in any of the above operations must be able to weigh to within 1/100th of a gram, shall be maintained in good working order and shall be subject to annual inspection by either the Alameda County Department of Agriculture/Weights and Measures or a licensed scale company.

## 16.8 PERSONNEL, DOCUMENTATION, DATA

### Education/Experience

All personnel involved in the production of cannabis products will have appropriate education and /or equivalent experience as well as applicable training.

Each person involved in the production of cannabis products must have appropriate and applicable experience.

### Training

All training of employees must be performed by a qualified person. All training of employees must be documented appropriately and available upon request.

### Standard Operating Procedures and Supporting Documents

Standard Operating Procedures must be in place for all processes conducted in the facility such that an employee can safely operate equipment to conduct processes as well as know what to do in the event of a malfunction.

Equipment manuals and Safety Data Sheets should be easily accessible and available to any person in the laboratory.

### Documentation

All processes, including but not limited to: Cultivation practices, Manufacturing Processes, etc.

1. Cultivation: A detailed record of the application of nutrients, pesticides, fungicides, etc must be documented in a laboratory notebook or a standardized form created by the laboratory. The documents should contain sufficient data so that the process could be recreated and redone exactly following the documents if necessary.
2. Manufacturing Processes: All processes should be governed by a Standard Operating Procedure which defines, step by step, how to perform a process so that it is reproducible.
3. Dispensing Processes- A log must be kept to record:
  - a. the date, type, and amount of Product tested;
  - b. the source(s) of any contaminated Medical Cannabis, Medical Cannabis Product or Edibles;
  - c. the report containing the results of the testing, including the name and level of the substance detected; and
  - d. the disposition of the Medical Cannabis, Medical Cannabis Product or Edible from which the contaminated sample was obtained, including the amount and the date and manner of disposition.

### Record and Data Retention

All records and data must be retained, either electronically or paper, for a minimum of three (3) years. Records and

data may be stored off site, if necessary. Records must be made available to the City upon request.

## 16.9 OPERATIONAL TESTING MANUAL

### TESTING REQUIREMENTS

In order to ensure the safety of all products, a full panel of safety and characterization testing will be performed. The following tests are outlined below:

- Potency Analysis
- Mold and Microbial
- Residual Solvent
- Terpene Analysis
- Heavy Metals
- Pesticides

### CANNABIS POTENCY TESTING

#### Rational

Potency testing, analyzing for the strength of cannabinoid concentration in a product, shall be conducted on all final products to be provided to the consumer. Potency and cannabinoid profile varies in each strain and products. This includes, but is not limited to flower, edibles, tinctures and topicals. The potency shall be determined as a safety measure for the patient. Knowing the cannabinoid profile allows patients and providers to determine the best type of products to be consumed for one's particular health needs.

The potency of the following cannabinoids should be determined for each product being tested:

- Delta 9 Tetrahydrocannabinol (D9THC)
- Tetrahydrocannabinolic Acid (THCA)
- Cannabidiol (CBD)
- Cannabidiolic Acid (CBDA)
- Cannabinol (CBN)
- Cannabigerol (CBG)
- Cannabigerolic Acid (CBGA)
- LOQ/LOD (Limit of Quantitation/Limit of Detection) Determination
- Linearity of Calibration Curves and Reportable Range
- Repeatability/Reproducibility
- Accuracy and Precision
- Specificity

#### Acceptable Limits

Acceptable limits do not apply to this test.

Additionally, Delta 8 Tetrahydrocannabinol (D8THC), Cannabichromene (CBC), tetrahydrocannabivarin (THCV), cannabidivarin (CBDV) may be tested for as their medicinal benefits may be of interest to particular patients. As more certified analytical standards become available they may be tested for as well.

#### Products to be Tested

All products should be tested prior to dispensing in order to provide patient with the most accurate information prior to consumption.

#### Acceptable Equipment

There are various instrumentation and methods available to analyze for cannabinoid concentration. At Coachillin' Holdings, in an effort to remain at the forefront of the industry, only the more recent methods will be accepted. HPLC (High Performance Liquid Chromatography) and UPLC (Ultra Performance Liquid Chromatography) based methods will be accepted.

All equipment used must be installed according to manufacturer's specifications. Regular preventative maintenance must be performed and documented as recommended by the manufacturer. Each analytical method used must be validated for each cannabinoid to show:

## **MICROBIAL CONTAMINANT TESTING**

### **Rational**

Microbial Contaminant testing shall be conducted in order to ensure there is no health and safety risk to the public.

### **Products to be Tested**

All flower to be dispensed and water based concentrates.

### **Acceptable Equipment**

PCR or the more traditional method of plating may be used. PCR is highly recommended as results can be generated in far less time than the traditional plating method, which could take 5-7 days.

### **Acceptable Limits**

| Substance                     | Acceptable Limits      |
|-------------------------------|------------------------|
| Shiga-toxin producing E. Coli | Less than 1 CFU/g      |
| Salmonella species            | Less than 1 CFU/g      |
| Total yeast and Mold          | <10 <sup>4</sup> CFU/g |
| Aspergillus flavus            | <1 CFU                 |
| Aspergillus niger             | <1 CFU                 |
| Aspergillus terrus            | <1 CFU                 |

## **RESIDUAL SOLVENT TESTING**

### **Rational**

Residual solvent testing should be performed on all products produced using hydrocarbon extraction to ensure the product is safe for the consumer. Acceptable limits of hydrocarbons are listed below. When closed loop carbon dioxide extraction is used, and carbon dioxide is the only solvent used in the production of a product, residual solvent testing is not necessary. If any solvent other than carbon dioxide is used, this test is mandatory.

### **Products to be Tested**

All concentrates produced using solvent based extraction techniques and processes.

### **Acceptable Limits**

| Solvent           | Acceptable limits (per gram) |
|-------------------|------------------------------|
| Butanes           | <800 Parts Per Million (PPM) |
| Heptanes          | <500 Parts Per Million (PPM) |
| Propane           | <500 Parts Per Million (PPM) |
| Benzene*          | <1 Parts Per Million (PPM)   |
| Toluene*          | <10 Parts Per Million (PPM)  |
| (m,p,o-) xylenes* | <1 Parts Per Million (PPM)   |

\*These solvents are not approved for use. Trace amounts may be present in solvents that are approved for use, limits here are based on amounts possible.

**TERPENES**

**Rational**

Terpenes are known to have medicinal benefits, particularly when in the presence of cannabinoids. In order to have a full understanding of the products, terpene testing will be performed in order to provide a full characterization panel of the cannabis components. The following terpenes are a basic list of what of terpenes present in cannabis that can be tested for: α-Pinene, β-Pinene, Myrcene, Limonene, β- Caryophyllene, Linalool, Borneol, Cineole (Eucalyptol), Delta-3-Carene, Pulegone, Terpineol, Humulene, Citronellol, Geraniol, Nerolidol, Ocimene and Terpinolene. Additional terpenes may be tested for at the discretion of the testing laboratory.

**Products to be Tested**

Flower and concentrates.

**Acceptable Limits**

Acceptable limits do not apply to this test.

**PESTICIDES**

**Rational**

Pesticides are frequently used in the cultivation of cannabis. The Environmental Protection Agency (EPA) has not yet been involved in setting acceptable limits for residual solvents on cannabis plant material. Coachillin will use California Department of Agriculture guidelines to determine acceptable pesticide usage and limits.

**Products to be Tested**

Flower and concentrates.

**Acceptable Limits**

To be determined based on California Department of Agriculture Regulations and Limits.

**HEAVY METALS**

**Rational**

The cannabis plant is used as a phytoremediator for certain heavy metals in the agricultural industry. In order to ensure the safety of all consumers, products should be tested for, to ensure there are no heavy metals present. Only Class 1 heavy metals will be tested for, Mercury, Cadmium, Arsenic and Lead. If conclusive data becomes available that heavy metals testing is not necessary, the necessity of this test can be reevaluated.

**Products to be Tested**

Flower and concentrates.

**Acceptable Limits**

| Heavy Metal | Acceptable limits (per gram) |
|-------------|------------------------------|
| Lead        | <10 Parts Per Million (PPM)  |
| Arsenic     | <10 Parts Per Million (PPM)  |
| Mercury     | <4 Parts Per Million (PPM)   |
| Cadmium     | <2 Parts Per Million (PPM)   |



# APPENDIX A

## SITE PLANS



IN THE CITY OF DESERT HOT SPRINGS, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

# PARCEL MAP NO. 37158

A SUBDIVISION OF PARCEL "A" OF LOT LINE ADJUSTMENT NO. 02-17, RECORDED SEPTEMBER 15, 2017, AS DOCUMENT NO. 2017-0384012, OF OFFICIAL RECORDS, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA, IN THE NORTHWEST QUARTER (NW1/4) OF SECTION 14, TOWNSHIP 3 SOUTH, RANGE 4 EAST OF THE SAN BERNARDINO MERIDIAN, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA. COACHELLA VALLEY ENGINEERS NOVEMBER, 2017

**BOUNDARY AND INDEX SHEET**

**BASIS OF BEARINGS**

THE BASIS OF BEARINGS FOR THIS SURVEY IS GRID NORTH, CALIFORNIA STATE PLANE COORDINATES, NAD83, ZONE VI, ESTABLISHED FROM HGS STATIONS "DSSC", "P600" AND "P565" EPOCH 2010.00.

**BASIS OF COORDINATES**

DSS NAD83, ZONE VI, BASED ON HGS STATIONS "DSSC", "P600" AND "P565" EPOCH 2010.00.

CGCS NAD83, ZONE VI, BASED ON HGS STATIONS "DSSC", "P600" AND "P565" EPOCH 2010.00.  
 N: 2210771.485 E: 6421179.081  
 N: 2228684.581 E: 6573244.200  
 N: 2314671.536 E: 6472048.408  
 CONVERGENCE ANGLE -0°09'27" @ PT. 1

**NOTE**

ALL DISTANCES SHOWN ARE GROUND DISTANCES. GRID DISTANCES CAN BE OBTAINED BY MULTIPLYING GROUND DISTANCES BY A CORRECTION FACTOR OF 0.999971964.

**SURVEYOR'S NOTES**

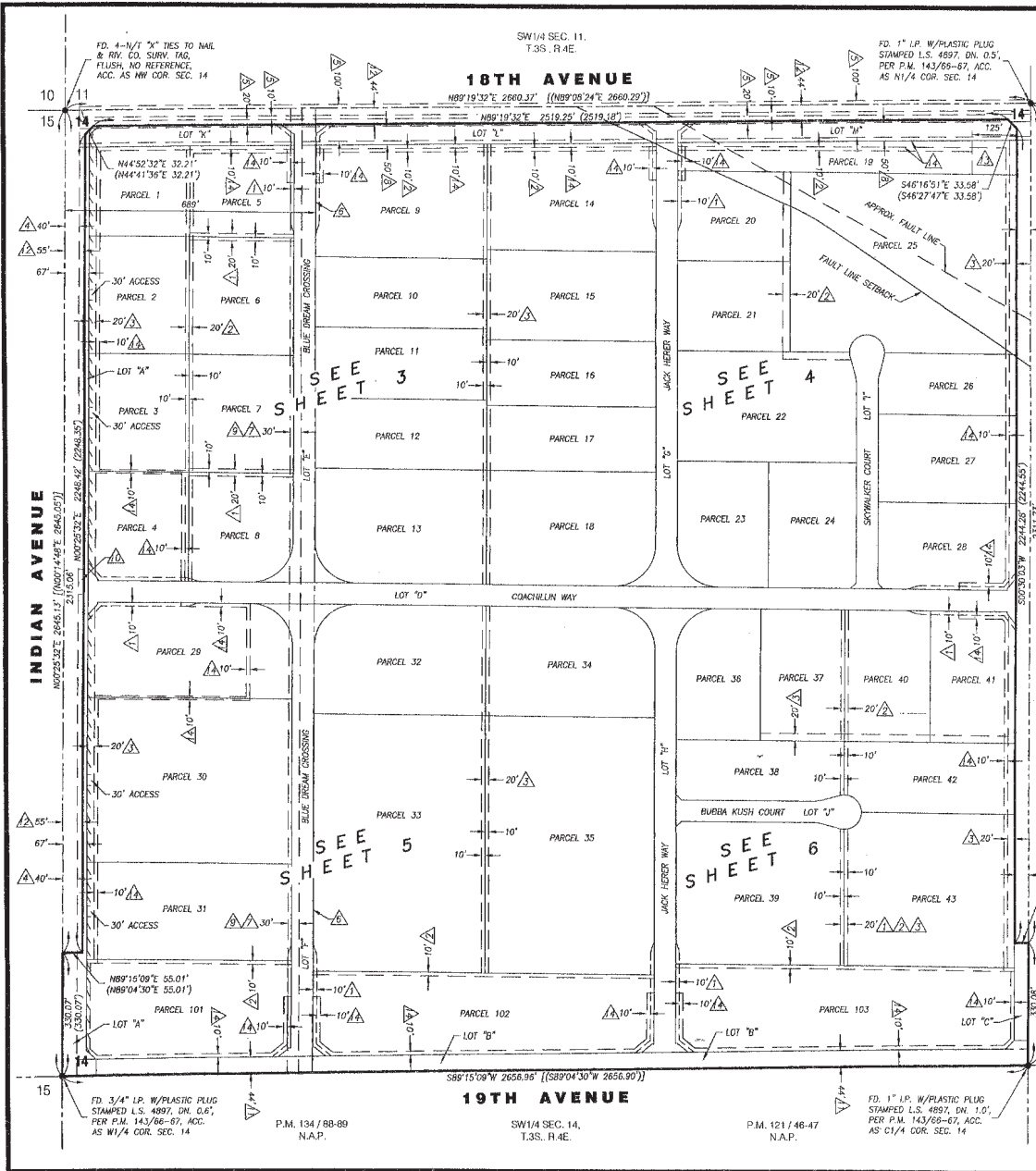
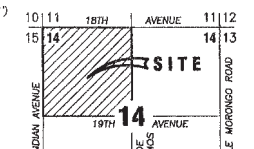
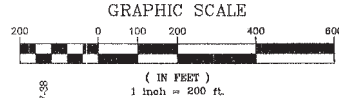
- INDICATES FOUND MONUMENT, AS NOTED
- INDICATES SET COPPERWELDED STAMPED L.S. 6532, FLUSH
- O.R. OFFICIAL RECORDS
- P.U.E. PUBLIC UTILITY EASEMENT
- P.M. PARCEL MAP
- R.S. RECORD OF SURVEY
- B.O.B. BASIS OF BEARINGS
- (R) RADIAL BEARING
- FD. FOUND
- C/L CENTERLINE
- DN. DOWN
- D.E. DRAINAGE EASEMENT
- L.S. LANDSCAPE
- RET. RETENTION
- N.A.P. NOT A PART
- ( ) INDICATES ACCESS RIGHTS RESTRICTED HEREON
- ( ) INDICATES RECORD DATA PER PARCEL MAP NO. 21783, P.M. 143/66-67, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA
- [ ] INDICATES RECORD DATA PER PARCEL MAP NO. 19126, P.M. 121/46-47, COUNTY OF RIVERSIDE, STATE OF CALIFORNIA

IN ACCORDANCE WITH SECTION 146.0089 OF THE CITY OF DESERT HOT SPRINGS MUNICIPAL CODE, ALL LOT CORNERS WILL BE SET AS FOLLOWS: SET NAIL & TAG STAMPED L.S. 6532 IN TOP OF CURB AT THE INTERSECTION OF FRONT LOT CORNERS AND IN TOP OF WALL AT REAR LOT CORNERS, EXCEPT WHERE A WALL DOES NOT EXIST, SET 1" I.P. WITH BRASS TAG STAMPED L.S. 6532, FLUSH.

**EASEMENT NOTES**

- ▲ 10' WIDE PUBLIC UTILITY EASEMENT ("P.U.E.") DEDICATED TO THE CITY OF DESERT HOT SPRINGS, AS SHOWN HEREON.
- ▲ 10' WIDE PRIVATE AGRICULTURAL/CHILLED WATER EASEMENT RESERVED HEREON.
- ▲ 20' WIDE PRIVATE DRAINAGE EASEMENT RESERVED HEREON.
- ▲ 40' WIDE EASEMENT FOR PUBLIC ROADWAY, PUBLIC UTILITIES AND INCIDENTAL PURPOSES IN FAVOR OF RIVERSIDE COUNTY PER DEED RECORDED 8/2/1932, IN BOOK 86, PAGE 92, O.R.
- ▲ 20' WIDE EASEMENT FOR PUBLIC UTILITIES AND INCIDENTAL PURPOSES AND 10' WIDE EASEMENT FOR ROAD PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA TELEPHONE CO. PER INST. RECORDED 1/6/1947, IN BOOK 80, PAGE 482, O.R.
- ▲ C/L OF AN EASEMENT FOR POLE LINES AND INCIDENTAL PURPOSES IN FAVOR OF CALIFORNIA ELECTRIC POWER COMPANY PER INST. RECORDED 5/16/1946, IN BOOK 1011, PAGE 004, O.R. (UNDEVELOPED WIDTH)
- ▲ 30' WIDE EASEMENT FOR PUBLIC UTILITIES AND INCIDENTAL PURPOSES IN FAVOR OF CALIFORNIA ELECTRIC POWER COMPANY PER INST. NO. 1962-46781, RECORDED 5/18/1962, O.R.
- ▲ 60' WIDE EASEMENT FOR COMMUNICATION SYSTEMS AND INCIDENTAL PURPOSES IN FAVOR OF AT&T PER INST. NO. 1972-90165, RECORDED 7/19/1972, O.R.
- ▲ 30' WIDE EASEMENT FOR POLE LINES AND INCIDENTAL PURPOSES IN FAVOR OF SOUTHERN CALIFORNIA EDSON PER INST. NO. 1195-12115, RECORDED 10/2/1975, O.R.
- ▲ 15' WIDE EASEMENT FOR WATER PIPELINE AND AFFURTANCES IN FAVOR OF DESERT HOT SPRINGS COUNTY WATER DISTRICT PER INST. NO. 1982-86915, RECORDED 6/20/1982, O.R.
- ▲ 44' WIDE EASEMENT FOR PUBLIC ROAD & DRAINAGE PURPOSES IN FAVOR OF RIVERSIDE COUNTY PER INST. NO. 1984-40348, RECORDED 2/29/1984, O.R.
- ▲ DEDICATION FOR STREET AND PUBLIC UTILITY PURPOSES IN FAVOR OF THE PUBLIC PER PARCEL MAP NO. 21783, P.M. 143/66-67, RECORDED 6/24/1987, O.R.
- ▲ PRIVATE AGRICULTURAL/CHILLED WATER AND AGRICULTURAL WELL EASEMENT RESERVED HEREON.
- ▲ 10' WIDE (VARIABLE WIDTH ON PARCEL 19) PRIVATE WALL, COMMUNICATIONS AND SECURITY SYSTEMS EASEMENT RESERVED HEREON.

CALLE DE LOS ROMOS  
 N.E. 1/4 SEC. 14,  
 T.3S., R.4E.  
 R.S. 17/37-38  
 N.A.P.



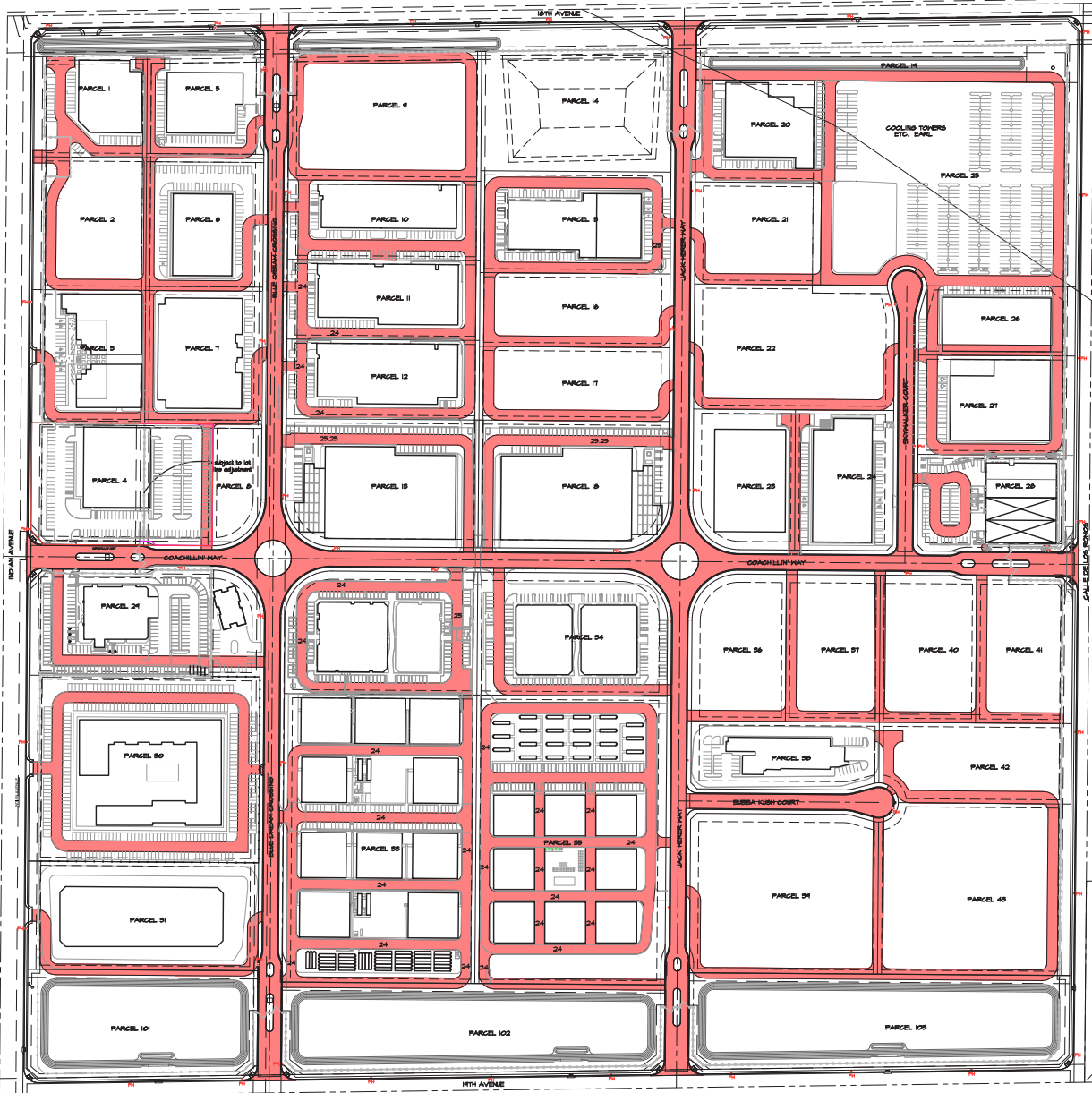
MASTER PLAN - Parcel Map

**A & ARCHITECTS**



Design Requirements and Guidelines - Revision May 24, 2020

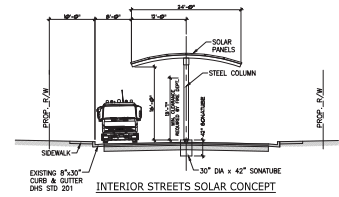
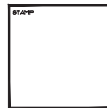
Coachillin' Industrial Cultivation & Ancillary Canna-Business Park



**COMMUNITY FIRE ACCESS PLAN**  
 NW 1/4 OF SECTION 14, TOWNSHIP 3 SOUTH, RANGE 4 EAST  
 APN #666-340-004 & 006  
 19th AVENUE, DESERT HOT SPRINGS, CA

**SITE ADDRESS**  
 N INDIAN CANYON DRIVE  
 BETWEEN 18TH AVE. AND  
 19TH AVE IN THE CITY OF  
 DESERT HOT SPRINGS, CA

**OWNER/DEVELOPER**  
 COACHILLIN' HOLDINGS, LLC  
 46-883 MONROE STREET # 203  
 INDIO, CA 92201  
 (760) 775-4000  
 ATTN: KENNY DICERSON



- 13,425 SOLAR PANELS
- FIRE ACCESS LANE =
  - 24' MIN. DRIVE AISLE WIDTH FOR TWO STORY BUILDINGS
  - 18' MIN. INSIDE RADIUS
  - 38' MIN. OUTSIDE RADIUS
  - 26' MIN. DRIVE AISLE WIDTH FOR THREE STORY BUILDINGS
  - 18' MIN. INSIDE RADIUS
  - 38' MIN. OUTSIDE RADIUS

**COACHILLIN' HOLDINGS, LLC**  
 IN THE NW1/4 OF SEC. 14, T.3S., R.4E., S.B.M., APN #666-340-004 & 006  
 19th AVENUE AND INDIAN CANYON RD., DESERT HOT SPRINGS, CA

COMMUNITY EMERGENCY & FIRE ACCESS PLAN



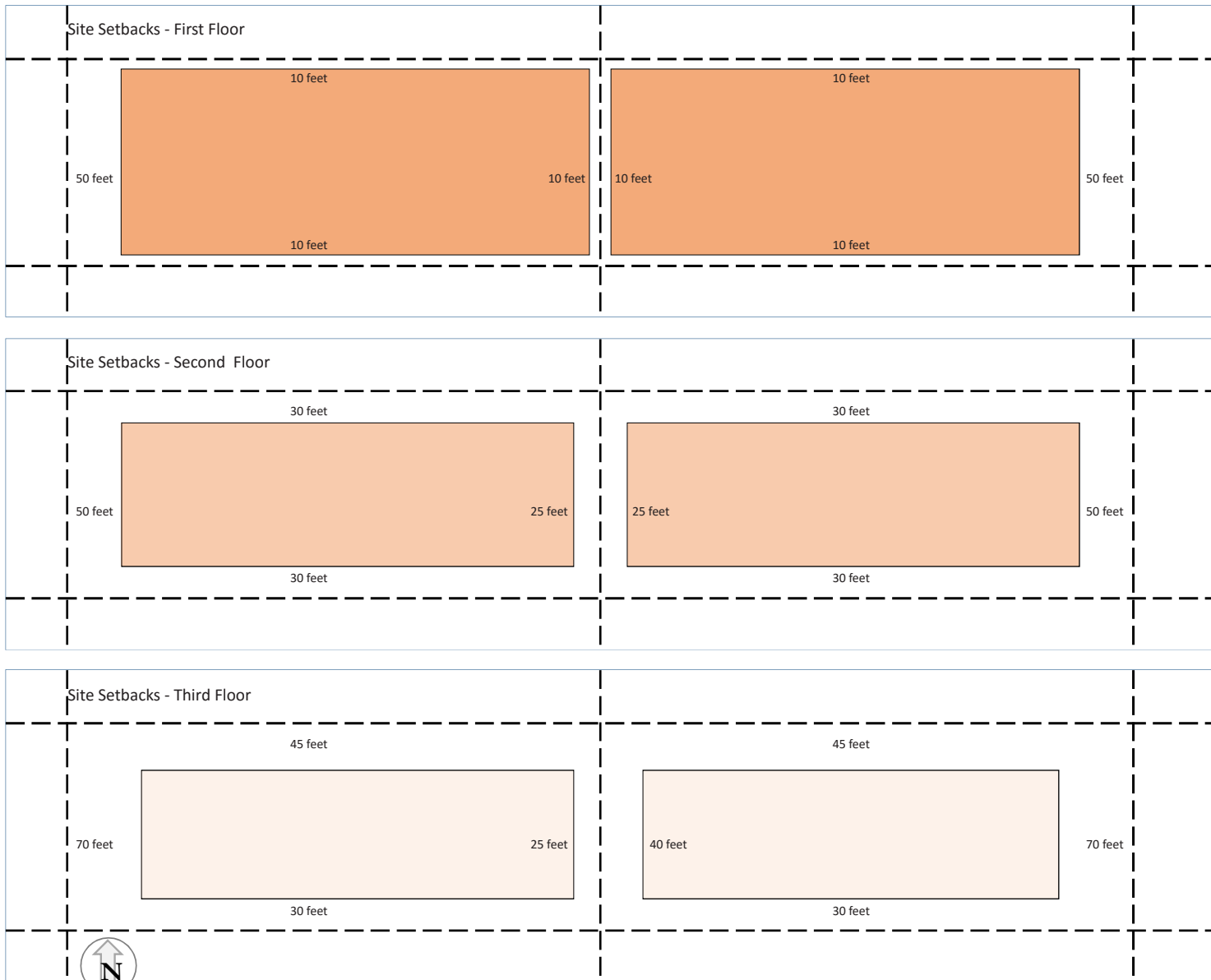
|            |          |
|------------|----------|
| DATE:      | 05/13/20 |
| REVISIONS: |          |
|            |          |
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COMMUNITY FIRE ACCESS PLAN  
**FA-1**

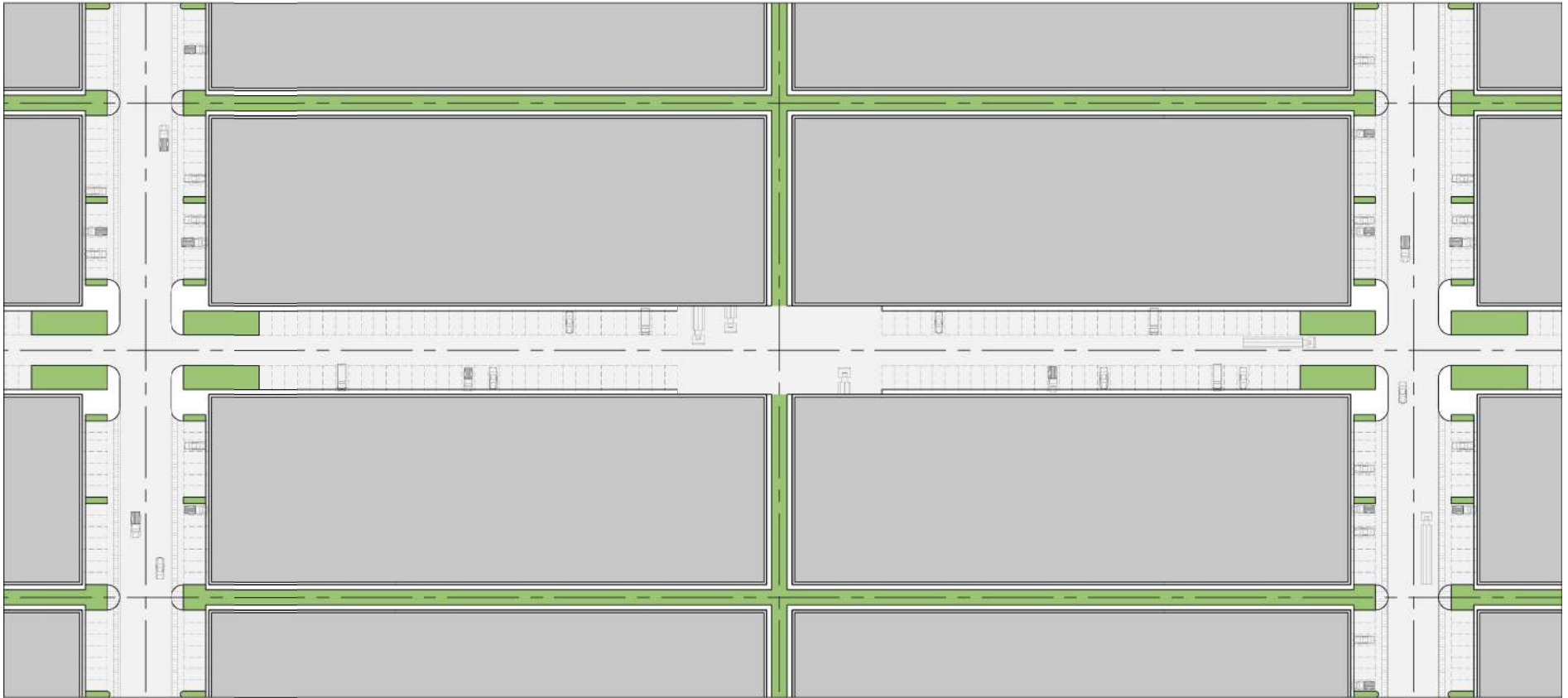
# APPENDIX B

## DRAWINGS

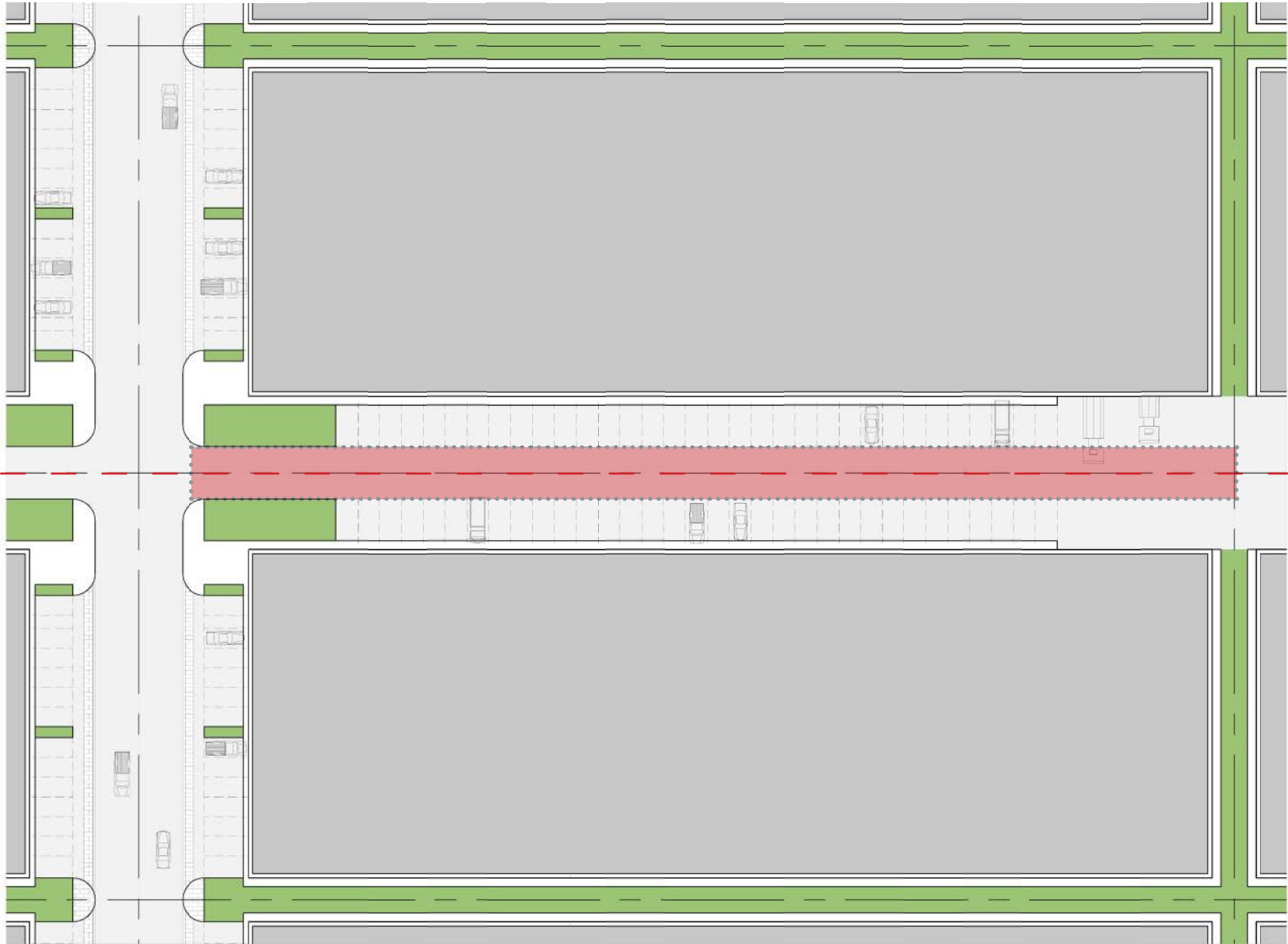




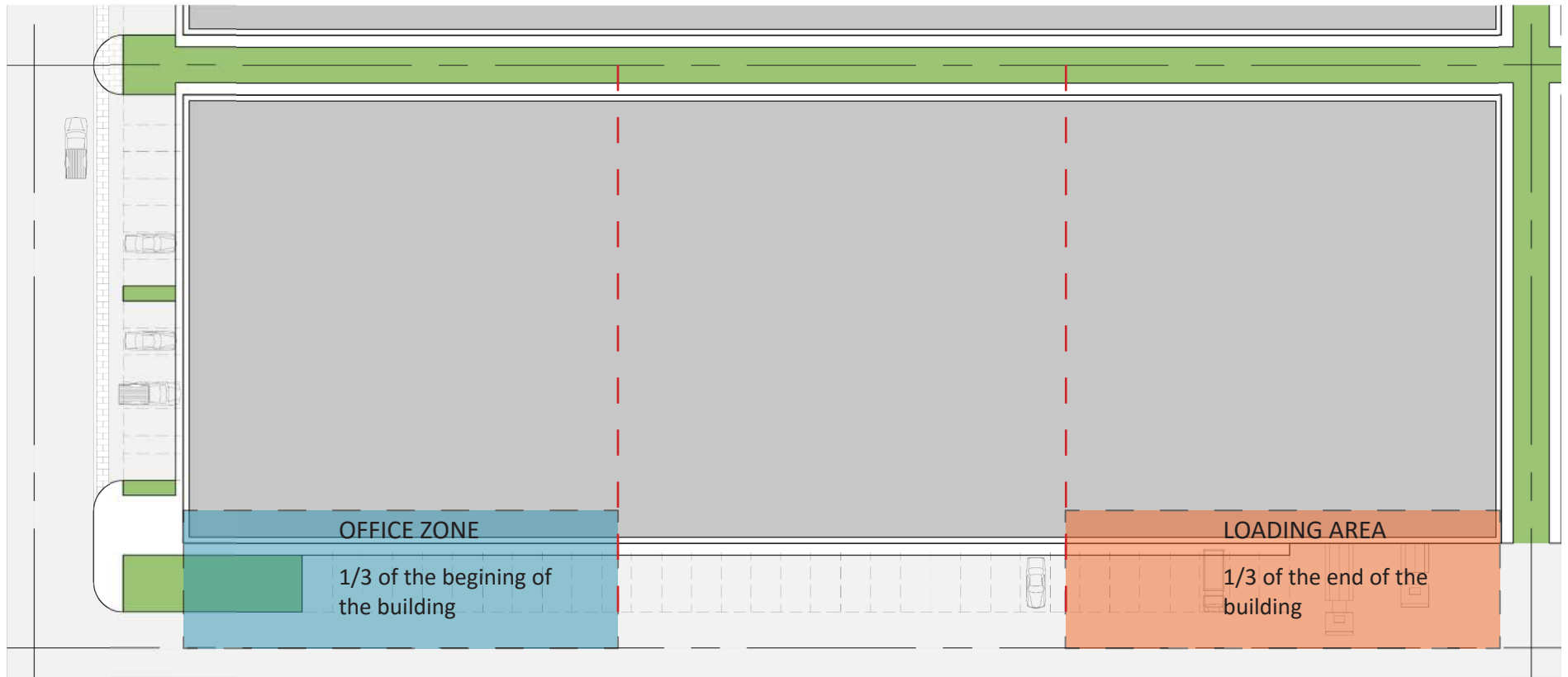
SETBACKS PLANS



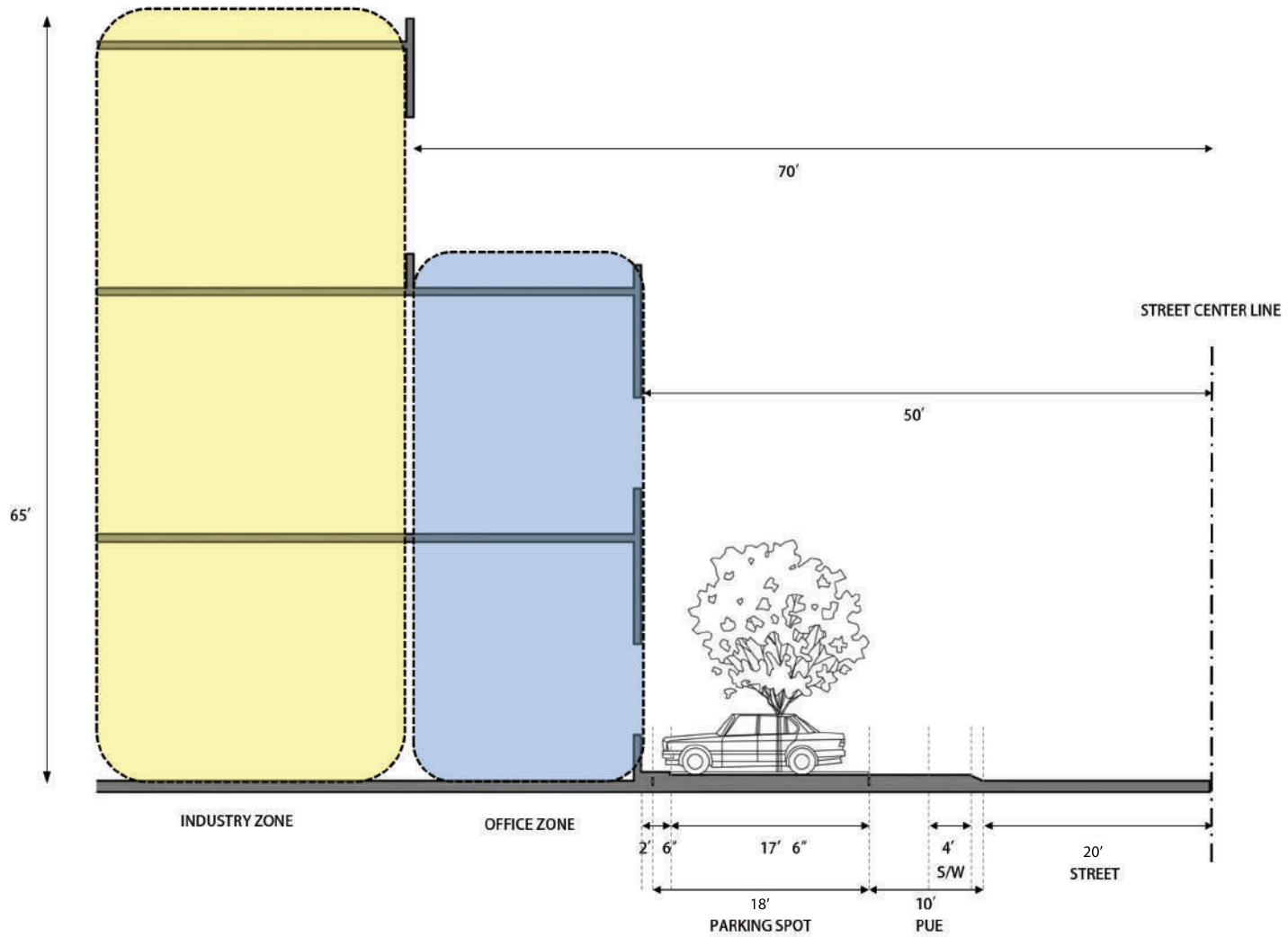
GENERAL NIEGHBORING PLAN



SHARED ACCESS PLAN



SINGLE BUILDING LAYOUT



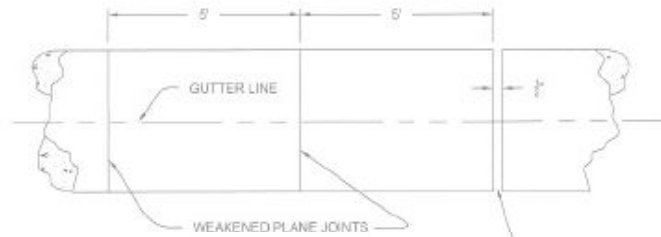
PROGRAM REZONING



# APPENDIX C

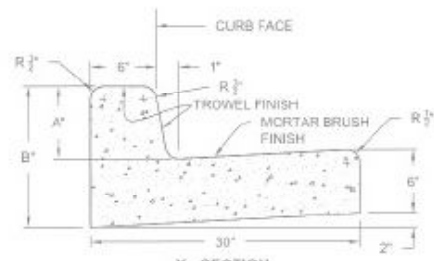
## CURB DESIGN STANDARD



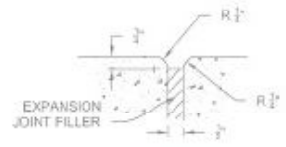


EXPANSION JOINTS AT ENDS OF CURB RETURNS & AT 30 FEET INTERVALS

**ELEVATION DETAIL**



**X - SECTION**



**EXPANSION JOINT DETAIL**



**WEAKENED PLANE JOINT DETAIL**

| DIM | 6" CURB | 8" CURB |
|-----|---------|---------|
| A   | 5"      | 8"      |
| B   | 12"     | 14"     |

NOTE:  
1. USE CLASS "B" CONCRETE.

APPROVED BY: *[Signature]* 3/13/07

SENE T. GINTHER CITY ENGINEER  
RCE 40422 EXPI 3/31/09

| DRAWN BY: | REVISIONS: | BY: | APRD DATE |
|-----------|------------|-----|-----------|
|           | 1          |     |           |
|           | 2          |     |           |
|           | 3          |     |           |

DATE: \_\_\_\_\_  
SCALE: NONE  
SHEET 1 OF 1

CITY OF  
DESERT HOT SPRINGS

**STANDARD  
30" CURB & GUTTER  
PUBLIC STREETS**

STANDARD No. 201





# APPENDIX D

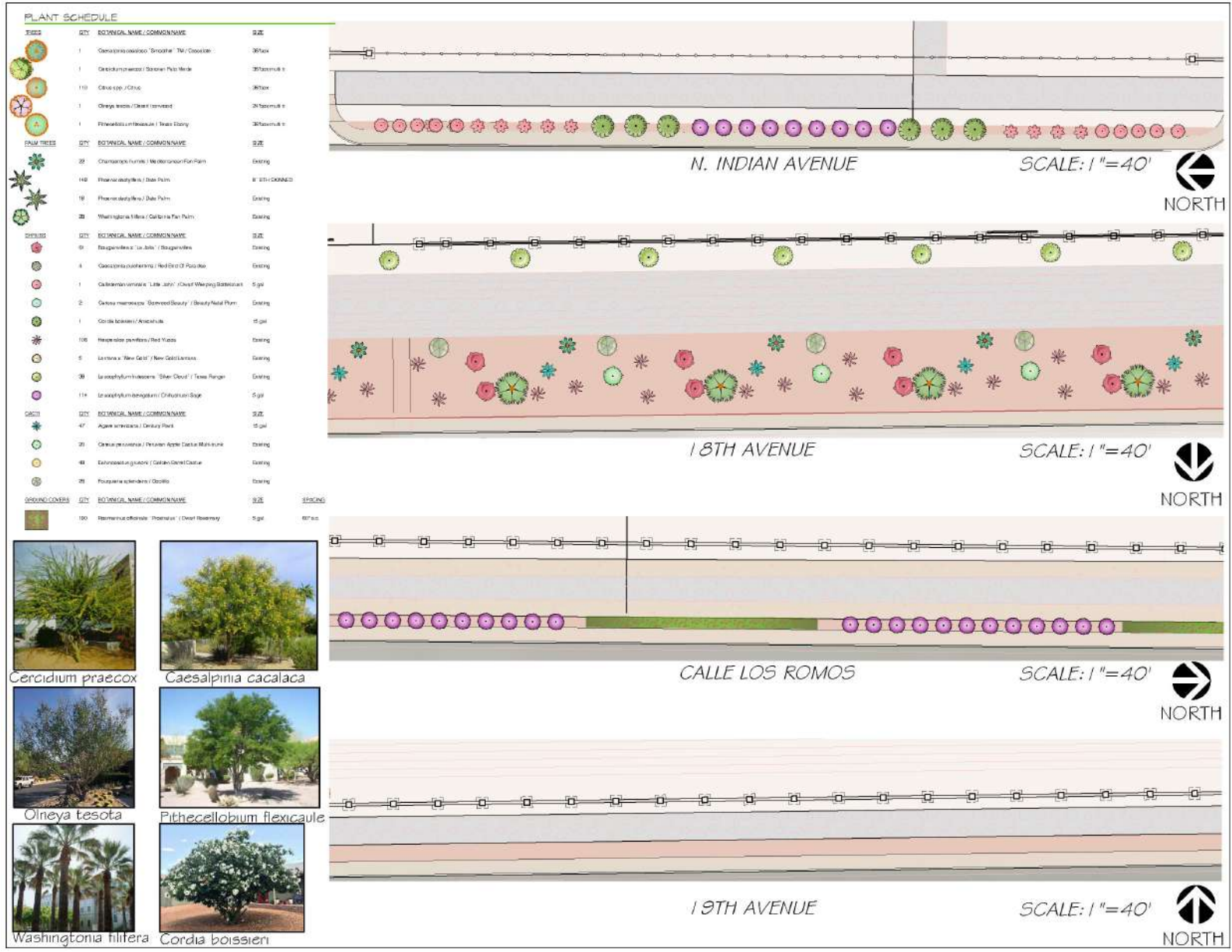
## LANDSCAPE MATERIALS TABLE



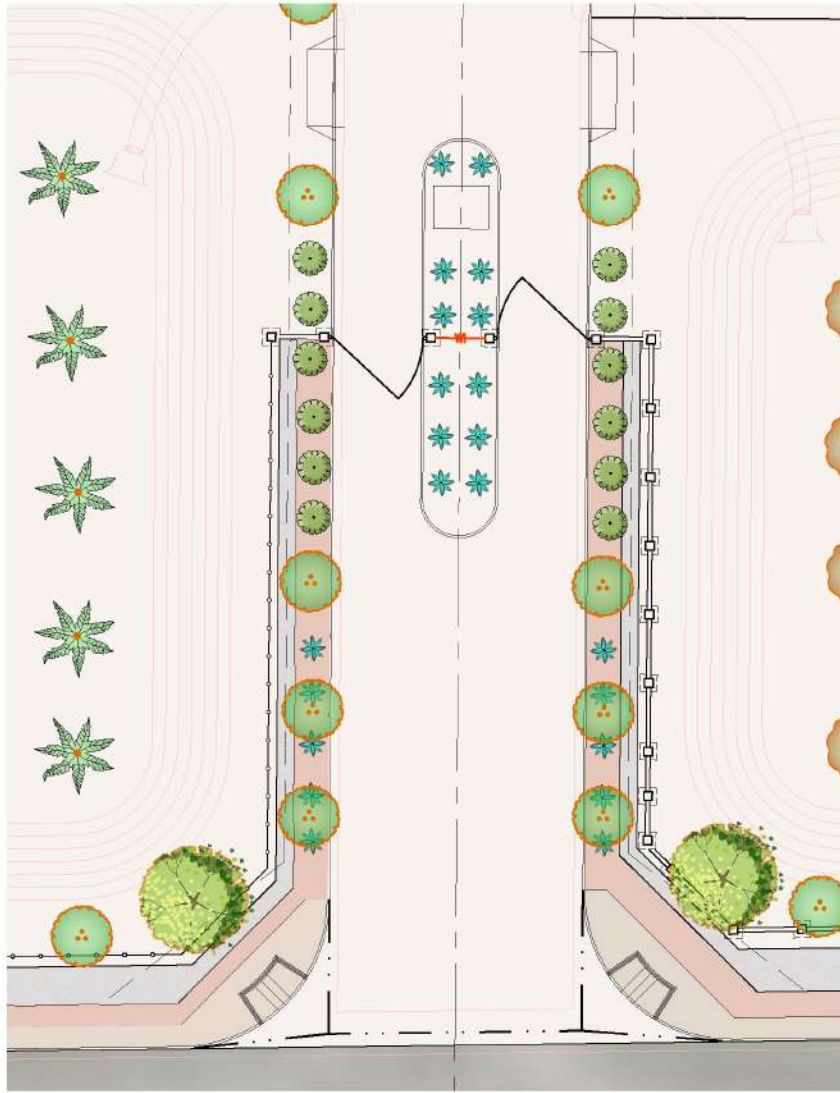
| PLANTS   | SIZE               | QUANTITY | PLANT FACTOR |
|--|--------------------|----------|--------------|
| <b>Trees</b>   |                    |          |              |
| <i>Acacia smallii</i><br>SWEET ACACIA  | 15 gal.<br>24" box | TBD      | Low/.2       |
| <i>Acacia willardiana</i><br>PALO BLANCO   | 24" box            | TBD      | Low/.2       |
| <i>Chilopsis linearis</i> "Lucretia Hamilton"<br>LUCRETIA HAMILTON DESERT WILLOW | 15 gal.            | TBD      | Low/.2       |
| <i>Parkinsonia praecox</i><br>PALO BREA  | 15 gal.<br>24" box | TBD      | Low/.2       |
| <i>Parkinsonia hybrid</i><br>DESERT MUSEUM                                       | 24" box            | TBD      | Low/.2       |
| <i>Prosopis glandulosa</i><br>TEXAS HONEY MESQUITE                               | 24" box            | TBD      | Low/.2       |
| <b>Shrubs and Groundcovers</b>   |                    |          |              |
| <i>Bougainvillea</i> "Torch Glow"<br>BOUGAINVILLEA                               | 5 gal.             | TBD      | Low/.2       |
| <i>Caesalpinia pulcherrima</i><br>RED BIRD OF PARADISE                           | 5 gal.             | TBD      | Moderate/.5  |
| <i>Calliandra californica</i><br>BAJA FARIY DUSTER                               | 5 gal.             | TBD      | Low/.2       |
| <i>Rosmarinus officinalis</i> "Tuscan Blue"<br>TUSCAN BLUE ROSEMARY              | 5 gal.             | TBD      | Low/.2       |
| <i>Muhlenbergia emersleyi</i> "El Toro"<br>BULL GRASS                            | 5 gal.             | TBD      | Low/.2       |
| <i>Leucophyllum pruinatum</i> "Sierra Bouquet"<br>SIERRA BOUQUET SAGE            | 5 gal.             | TBD      | Low/.2       |
| <i>Leucophyllum frutescens</i> "Rio Bravo"<br>TEXAS RANGER                       | 5 gal.             | TBD      | Low/.2       |
| <i>Tacoma stans</i> "Gold Star"<br>GOLD STAR                                     | 5 gal.             | TBD      | Low/.2       |
| <i>Ruellia peninsularis</i><br>DESERT RUELLIA                                    | 5 gal.             | TBD      | Moderate/.5  |
| <i>Dodonaea viscosa</i><br>GREEN HOPBUSH   | 5 gal.             | TBD      | Low/.2       |
| <i>Simmondsia chinensis</i><br>JOJOBA  | 5 gal.             | TBD      | Low/.2       |
| <i>Nolina longifolia</i><br>MEXICAN GRASS TREE                                   | 5 gal.             | TBD      | Low/.2       |
| <i>Dasyliirion wheeleri</i><br>DESERT SPOON                                      | 5 gal.             | TBD      | Low/.2       |
| <i>Hesperaloe parviflora</i><br>RED HESPERALOE                                   | 5 gal.             | TBD      | Low/.2       |
| <i>Muhlenbergia capillaries</i> "Regal Mist"<br>REGAL MIST                       | 5 gal.             | TBD      | Low/.2       |
| <i>Acacia redolens</i> "Desert Carpet"<br>DESERT CARPET                          | 1 gal.             | TBD      | Low/.2       |
| <i>Lantera</i> "New Gold"<br>NEW GOLD LANTANA                                    | 1 gal.             | TBD      | Low/.2       |
| <i>Rosmarinus officinalis</i><br>TRAILING ROSEMARY                               | 1 gal.             | TBD      | Low/.2       |



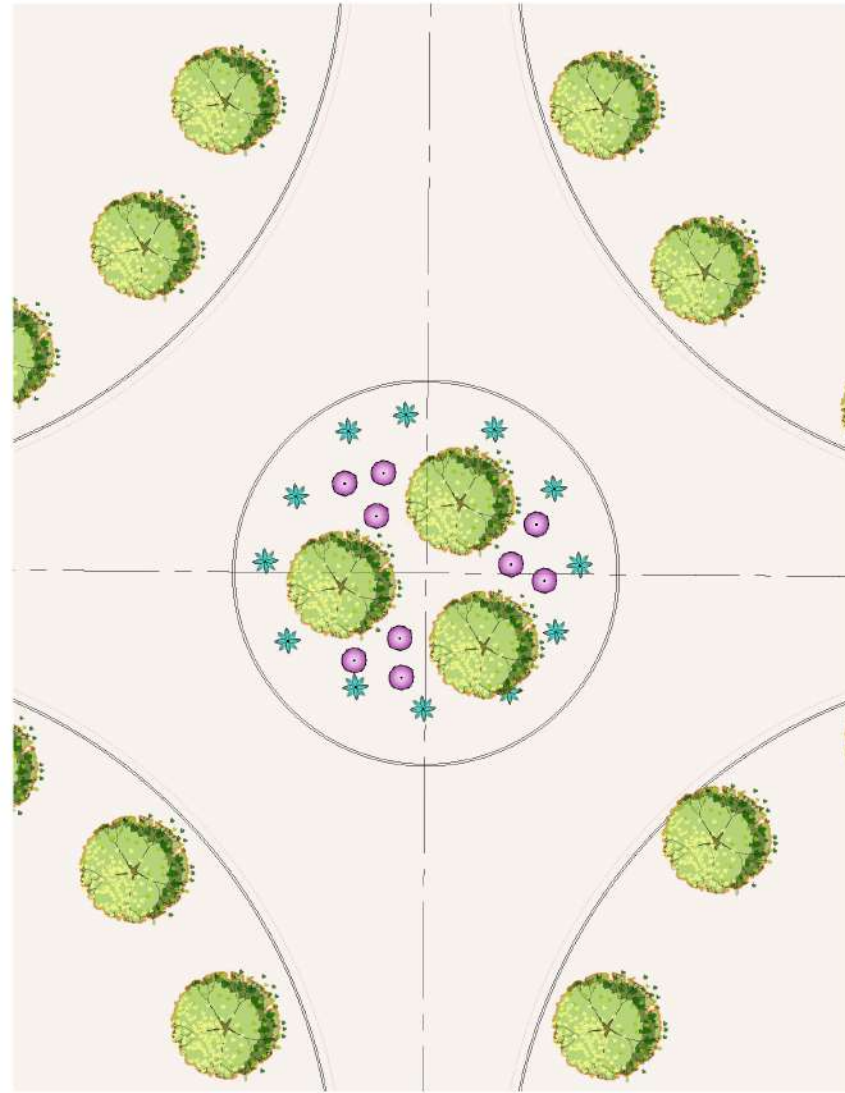
SITE LANDSCAPE PLAN



SITE LANDSCAPE PLAN



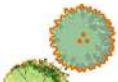





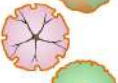





























TYPICAL ENTRANCE  
SCALE: 1"=40'



TYPICAL ROUNDABOUT  
SCALE: 1"=40'

SITE LANDSCAPE PLAN

# PLANT SCHEDULE

| TREES  | BOTANICAL NAME / COMMON NAME                          | SIZE                | SHRUBS  | BOTANICAL NAME / COMMON NAME                                    | SIZE        |
|--|---|---------------------|---|---|-------------|
|     | Caesalpinia cacalaco `Smoothie` TM / Cascalote        | 36"box              |    | Bougainvillea x `La Jolla` / Bougainvillea                      | 5 gal       |
|     | Cercidium praecox / Sonoran Palo Verde                | 36"box multi tr.    |    | Caesalpinia pulcherrima / Red Bird Of Paradise                  | 5 gal       |
|     | Citrus spp. / Citrus                                  | 24"box              |    | Callistemon viminalis `Little John` / Dwarf Weeping Bottlebrush | 5 gal       |
|     | Olneya tesota / Desert Ironwood                       | 24"box multi tr.    |    | Carissa macrocarpa `Boxwood Beauty` / Beauty Natal Plum         | 5 gal       |
|     | Pithecellobium flexicaule / Texas Ebony               | 36"box multi tr.    |    | Cordia boissieri / Anacahuita                                   | 15 gal      |
| <b>PALM TREES</b>  | <b>BOTANICAL NAME / COMMON NAME</b>                   | <b>SIZE</b>         |    | Hesperaloe parviflora / Red Yucca                               | 5 gal       |
|     | Chamaerops humilis / Mediterranean Fan Palm           | 36"box              |    | Lantana x `New Gold` / New Gold Lantana                         | 5 gal       |
|     | Phoenix dactylifera / Date Palm                       | 8' BTH SKINNED      |    | Leucophyllum frutescens `Silver Cloud` / Texas Ranger           | 5 gal       |
|     | Washingtonia filifera / California Fan Palm           | 10'-14' BTH SKINNED |    | Leucophyllum laevigatum / Chihuahuan Sage                       | 5 gal       |
| <b>CACTI</b>   | <b>BOTANICAL NAME / COMMON NAME</b>                   | <b>SIZE</b>         | <b>GROUND COVERS</b>  | <b>BOTANICAL NAME / COMMON NAME</b>                             | <b>SIZE</b> |
|     | Agave americana / Century Plant                       | 15 gal              |    | Rosmarinus officinalis `Prostratus` / Dwarf Rosemary            | 5 gal.      |
|     | Cereus peruvianus / Peruvian Apple Cactus Multi-trunk | 15 gal              |   |   |             |
|     | Echinocactus grusonii / Golden Barrel Cactus          | 14" dia.            |   |   |             |
|    | Fouquieria splendens / Ocotillo                       | 8' HT, 12 cane      |   |   |             |
|   | Agave americana                                       |                     |   | Cercidium praecox   |             |
|   | Bougainvillea   |                     |   | Caesalpinia cacalaca  |             |
|   | Hesperaloe p.   |                     |   | Washingtonia filifera   |             |
|  | Leucophyllum f.                                       |                     |   |   |             |
|   | `Little John`   |                     |  | Olneya tesota   |             |
|   | `Boxwood Beauty`                                      |                     |  | Pithecellobium flexicaule                                       |             |
|   | Cereus p.   |                     |  | Cordia boissieri  |             |
|  | Caesalpinia p.  |                     |   |   |             |

## SITE LANDSCAPE PLAN



# APPENDIX

## CRIME PREVENTION



## SITE SECURITY

\*\*For detailed Project Security Plan, please reference Specific Plan Appendix 10.2.

The COACHILLIN' Security and Control Plan ("Plan") details all-encompassing security provisions that cover COACHILLIN' CANNABIS & ANCILLARY BUSINESS INDUSTRIAL PARK tenants and their products - from cultivation, production, packaging, labeling, tracking and transportation to distribution to the licensed dispensaries. Plan provisions will comply with or exceed local laws and ordinances, the California Medical Marijuana Regulation and Safety Act ("MMRSA"), best practices from other regulated states and guidelines set by the federal government in the 2012 Cole Memorandum. All COACHILLIN' Industrial Cultivation & Ancillary Canna-Business Park ("COACHILLIN'") facilities will be operated with the safety and security of the local population, staff, and medicine as the primary concern. Understanding that there may be internal and external security threats to this property, COACHILLIN' will implement a first-of-its-kind security program to combat all known and potentially unknown threats. COACHILLIN' has anticipated threats from every arena, including but not limited to physical, cyber, and procedural security for all facilities and operations. The COACHILLIN' program is designed to give every tenant and employee the responsibility of ensuring and working within a secure environment. Our security specialists and management team have developed detailed policies and procedures, along with training programs that enhance prevention, awareness, reporting, and responsible incident management for the entire company.

### Crime Prevention Through Environmental Design

COACHILLIN' will use Mobile Two Man teams to monitor and patrol the outer security perimeter defined as the borders of the property. The perimeter would also be

defended by natural barriers (landscaping), clearly marked with Private Property No Trespassing signage, and surveillance technology. The intermediate security perimeter will include all cultivation buildings, storage facilities and offices. This perimeter would feature man-made "stand-off zones" for primary buildings as well as physical barriers to restrict pedestrian and vehicular traffic. This intermediate perimeter would be secured by CCTV and security guards. The interior cultivation and processing facilities will constitute the inner perimeter – the proprietary zone. Walls, doors and windows become a critical layer of security. Access control to this vital zone is mandatory, requiring a visible employee identification program. All aspects of security technology have application to the inner perimeter.

COACHILLIN' will use Crime Prevention through Environmental Design (CPTED) principles to ensure that the look and feel of the production facility will enhance the surrounding environment, rather than detract from it, while ensuring there are no potential blind spots for intruders to conceal themselves. COACHILLIN' will create security measures that respect our neighbors and community and do not violate what we ourselves would not want to see or hear in our backyards.

The COACHILLIN' Security Plan lends itself to creating an environment that prohibits any theft or diversion of medical cannabis and the proceeds from their sales. Access to our facilities will be limited only to individuals with prior authorization to enter, and only on an as needed and scheduled basis.

### Security Philosophy

COACHILLIN' believes the best way to approach this project is through a team approach. This team approach will be reflected throughout our security plan, but is clearly evident in the Company's security philosophy.

COACHILLIN' adhered to the following criteria and approach in initiating a cutting-edge security plan and in defining security goals, objectives, and techniques:

Security professionals have been involved in the project team from the earliest stages. Including the security principles in the design and development phase has allowed COACHILLIN' to incorporate our expertise and take advantage of opportunities to use the surrounding natural and man-made environment in the physical security plan (i.e. the use of natural physical barriers and landscaping to provide access control and security shielding). COACHILLIN's security philosophy incorporates natural and creative landscaping to discourage or mitigate a vehicle attack on the facility without being recognized by the public as a security measure.

Environmental security strategies will include physical security design, employee/citizen and law enforcement participation in a team approach to facility security. These strategies are based on internationally known and recognized Crime Prevention through Environmental Design (CPTED) principles. These principles, which include the use of lighting, plantings, ground textures and common areas, deter crime and reduce vulnerabilities to violence and theft. The cultivation facility will strive to be a "good neighbor", ensuring that security lighting does not become lighting pollution or serve as a source of citizen discontent. Our design includes the use of low light cameras, motion detection devices and lighting that fits into the local community.

The security design includes state-of-the-art technology, digital systems, and "all-smart" devices. All system software will utilize open architecture and protocols so that the facility is never "locked into" or dependent on a single manufacturer or vendor.

Security systems are designed to be flexible, allowing the system to cost-effectively expand and contract to meet changing needs and risk levels. Security systems management and controls will be standardized to minimize staff training requirements and reduce annual operating costs. System and equipment selection will be based on analysis of life-cycle costs rather than only

initial capital outlay.

The cultivation/processing security command center will include the latest in security technology, with components that will enable the center to serve as a command post during any emergency operation.

The entire security program has been designed to prevent loss through diversion and effective risk management so that security contributes to the overall sense of cooperation within the community we serve, while ensuring our operation remains intact and secure throughout any situation.

The COACHILLIN' approach ensures these facilities will become the model for safety and security while still maintaining the sense of community required. The background and expertise of the COACHILLIN' team has provided an unmatched approach and commitment to the safety and security of our facilities.

### **Phase One**

Concurrent with developing a plan outlining functional and operational needs, the COACHILLIN' Security Force Team has been extensively involved with the project manager and architect, and this will continue throughout the life of the project and ensure that the ultimate goals of COACHILLIN' are met on schedule. In developing the blueprint during Phase One, COACHILLIN' feels that a key ingredient to the success of this project is to ensure that all construction contractors and other service providers are on the same page as our Security Force Team to ensure the development of appropriate security measures. This reduces issues that generally come up later in a project of this dimension, as the majority of those concerns will have been dealt with during the initial stages of construction. The security measures that will be considered will include all areas of each cultivation facility.

We have worked on identifying all aspects of the project that present a security risk. The Vulnerability and Security

Assessment is a logical process that evaluates every aspect of the planned site, including, but not limited to, interior, exterior, ingress, egress, transportation routes, and the surrounding neighborhoods. Critical infrastructure that is an integral part of the day-to-day operation of this project will be evaluated by working closely with the appropriate authorities. Local, state and federal agencies will be included throughout the process as the need arises.

The COACHILLIN' Vulnerability and Security Assessment begins in the planning stage with a meticulous review of all available documentation, including site plans. All Security Force Team documents bring to light every aspect of security and safety including crime, diversion, terrorism, fire and medical emergencies. Continuous review and evaluation of all documents by the Security Team throughout the project development stages will include focus on systems such as fire safety, intrusion detection, etc. During this period the Security Team will build a relationship with critical infrastructure suppliers including, but not limited to, voice and data communication, power, and water.

Throughout Phase One the team will identify vulnerabilities to the facilities and the surrounding area. Every aspect of the facilities' effect on the neighborhood, from the construction phase to completion, will be taken into account. This includes public access, deliveries and utility services. Every phase of this project creates a different risk potential which must be rated for inclusion as an actionable item. The security assessment will be the springboard to developing both a state-of-the-art security program and a detailed security protocol for all situations. The assessment and testing in Phase One will continue through to the beginning of Phase Two.

### **Phase Two**

As programming and schematic design begins, the COACHILLIN' Security Team, working with the project

managers, will create the physical security program conceptualized during Phase One. All security design phases will be coordinated with the architect and will be incorporated in the design schedule. The role of security technology is important in today's environment, but equally critical are the operating procedures and policies surrounding those systems. These procedures embrace all day-to-day, emergency and crisis management scenarios. The COACHILLIN' Security Force Team will refine those procedures during engagement in Phase Two, using the information gained in the first phase.

COACHILLIN' will produce and continually refine detailed Security Protocol and Program Handbooks that cover the security of all structures (cultivation, command and control, storage, etc.) as well as transportation and other aspects of the operation. Long-term site security begins well before the first shovel hits the ground. A continuous review of project plans and their progress ensures that all required security measures are incorporated into the physical structure. All selected systems will undergo rigorous testing as they are installed and integration testing will occur as other systems come on-line. This ensures that all systems work together and achieve the designed goals. The COACHILLIN' Security Force Team contains specialists in deploying integrated systems and procedures for testing. Fully integrated systems and procedures testing is completed and proven before any facility opens for its intended use.

### **Phase Three**

Throughout the life of the facility, the requirement to review and refine security systems and procedures is imperative. On an ongoing and random basis, the COACHILLIN' Security Team will conduct testing of alarm and other service providers as well as perform technology reviews and drills of facilities, procedures and communications. Our commitment to vigilance is unwavering.

## GENERAL PREVENTION MEASURES

### Video Management System

A Video Management System (VMS) will be deployed throughout the CHL facility. The actual configuration of VMS will be solely dependent on the planned layouts for the cultivation facilities. Security Video Cameras (SVC) plan, cameras will be positioned in strategic locations throughout the facility to monitor activity in all areas.

All VMS control equipment will be located at the Security Tactical Operations Center and include a server, recording servers, workstation, and system software, as required to meet the video system requirements. All operations within the Coachillin' Canna-Business Park must conform to the unified surveillance system requirements as required by Coachillin' Technology LLC (CTECH).

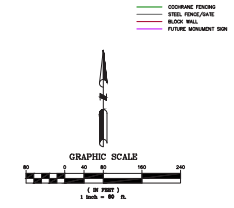
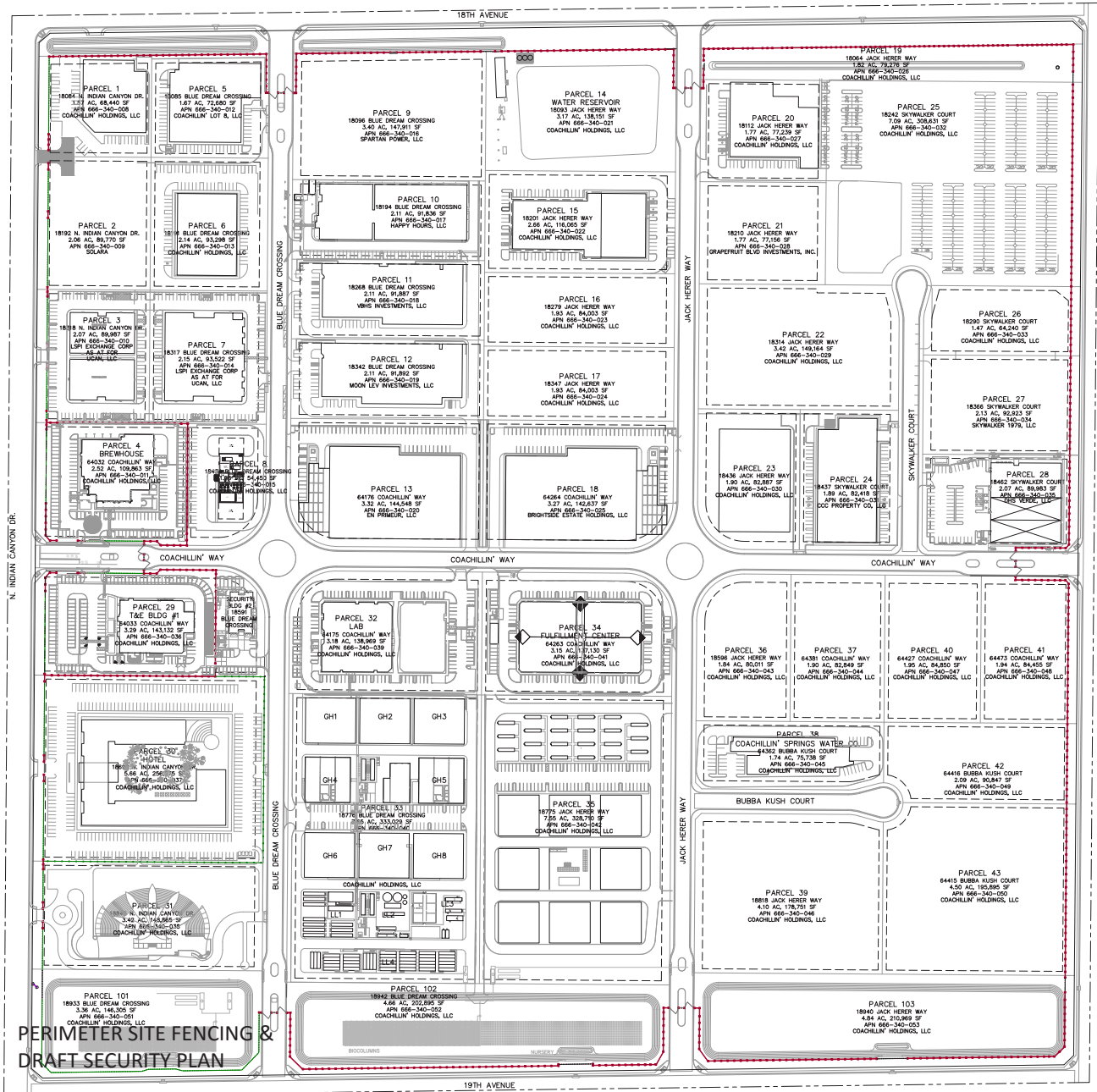
### Lighting

The lighting at all the exterior doors and walk areas, around the parking lots and grounds and at the fence and gate will meet or exceed the requirements for Security Lighting.

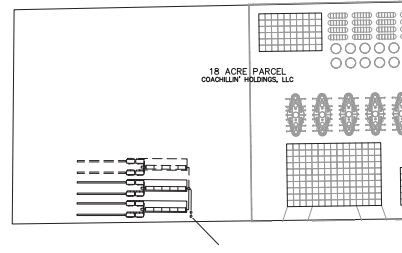
Infrared illumination devices will be deployed in certain areas to enhance the security surveillance of the property.

Utilization of motion sensor lights to be implemented.

Owners must submit their parcel designs including architectural and landscape design and security plan to owners association to review by security management and approval.



COACHILLIN' HOLDINGS, LLC  
IN THE NW1/4 OF SEC. 14, T.3S., R.4E., S.E.M.,  
APN #666-340-004 & 006  
19th AVENUE, DESERT HOT SPRINGS, CA



PERIMETER SITE FENCING &  
DRAFT SECURITY PLAN

| NO. | DATE | ISSUES | REVISION |
|-----|------|--------|----------|
|     |      |        |          |
|     |      |        |          |
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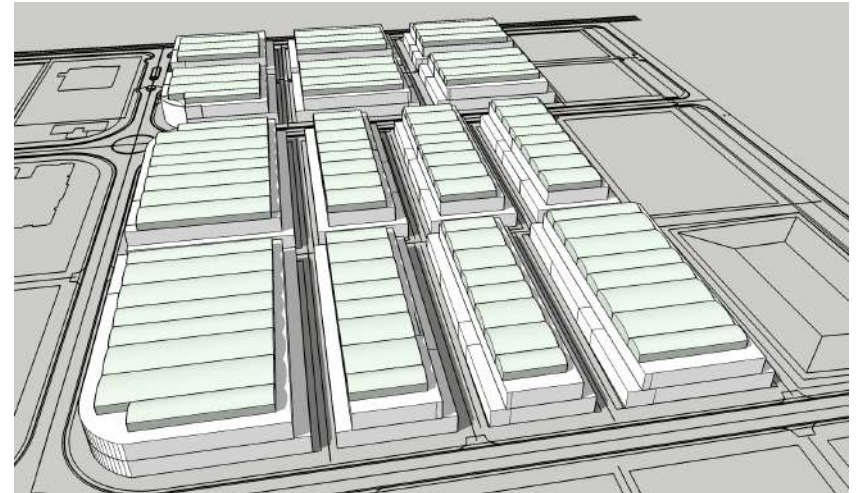
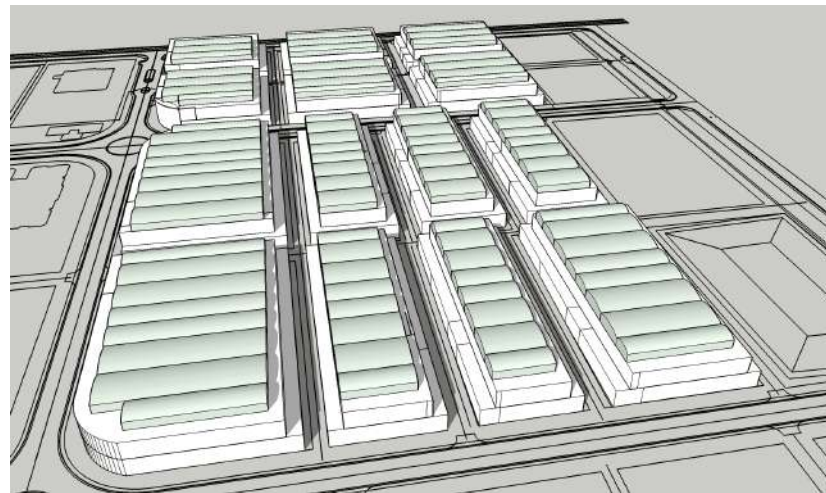
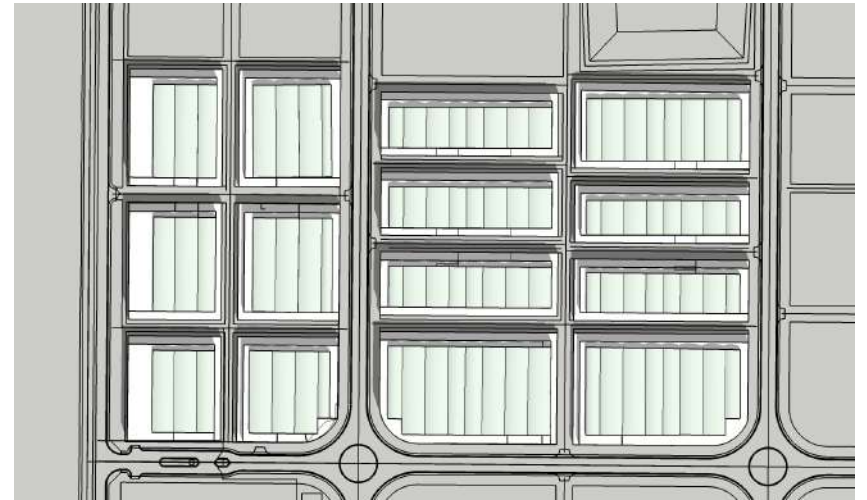
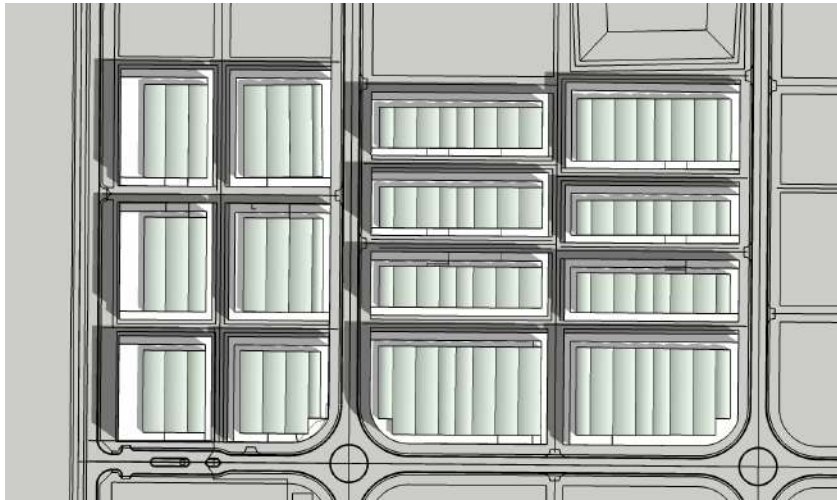
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# APPENDIX

## SHADOW STUDY



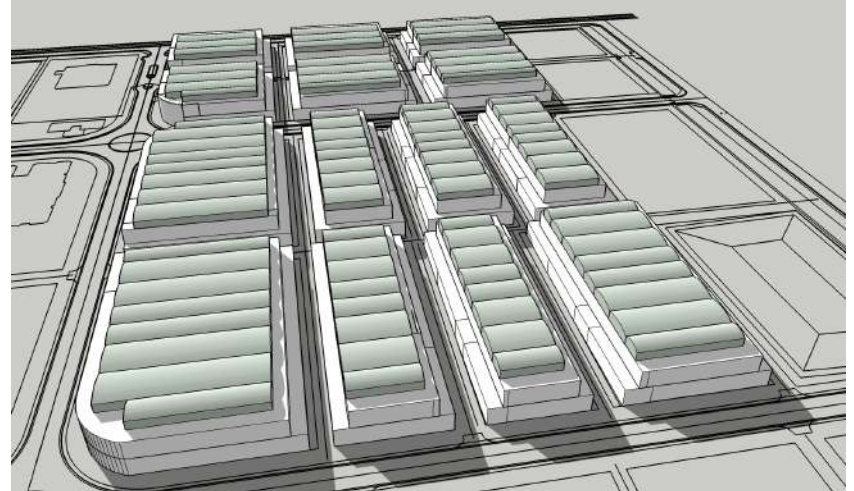
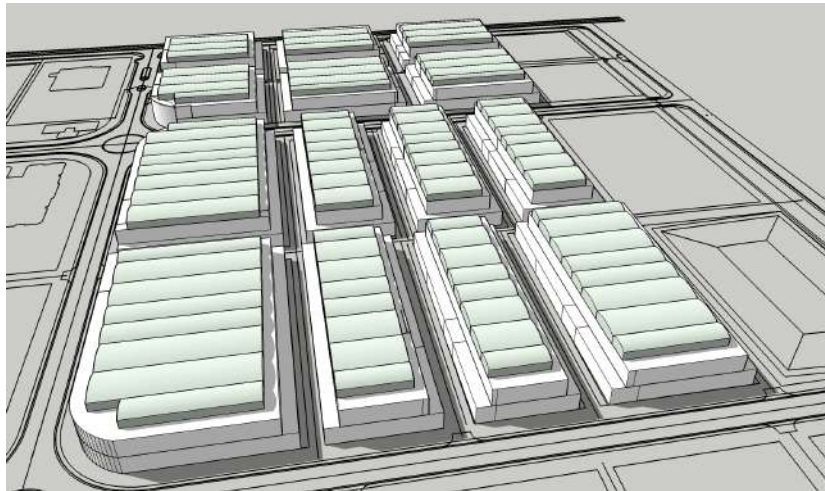
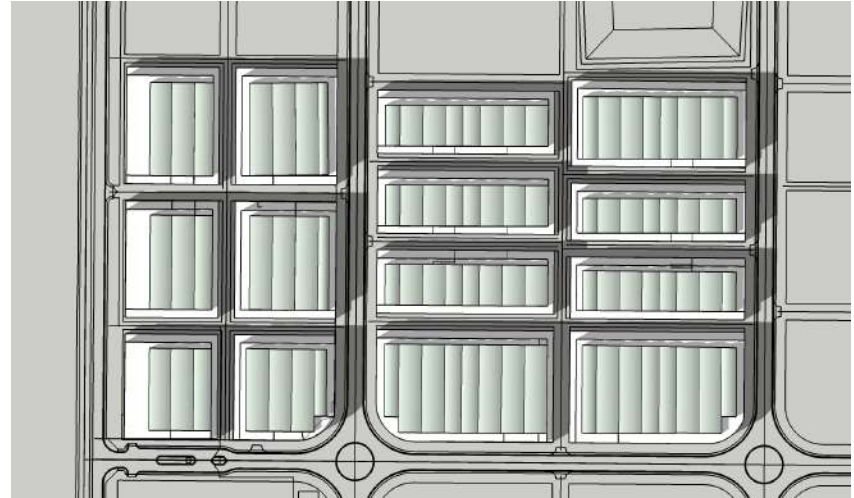
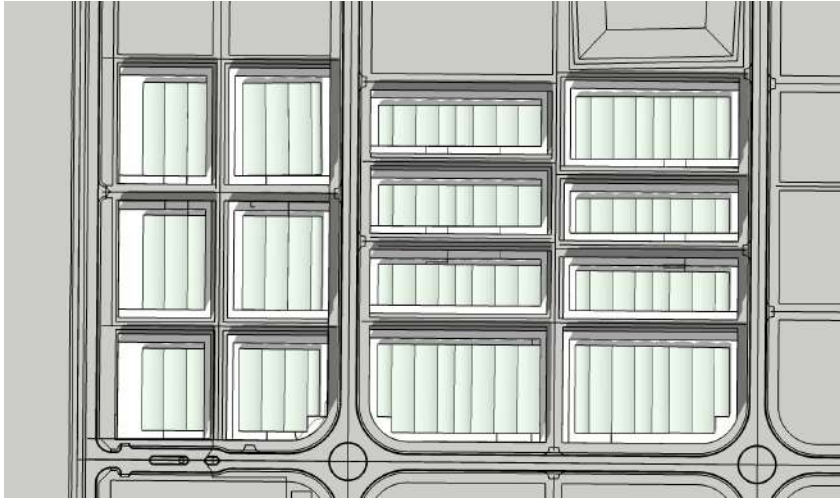
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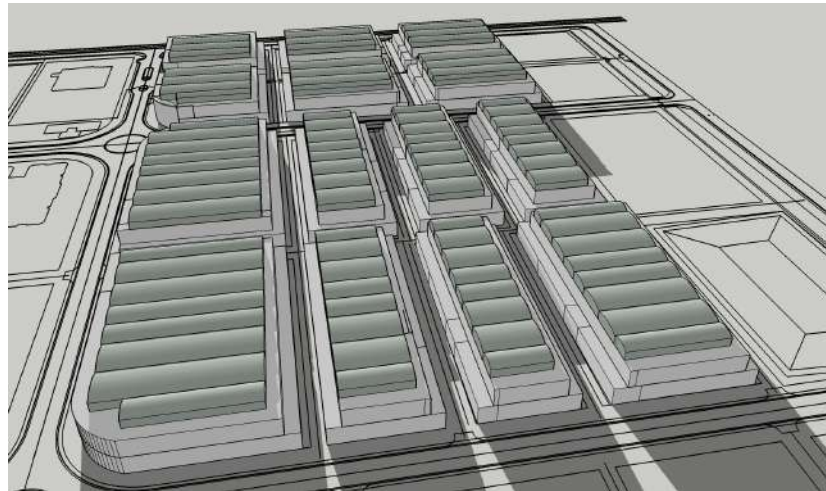
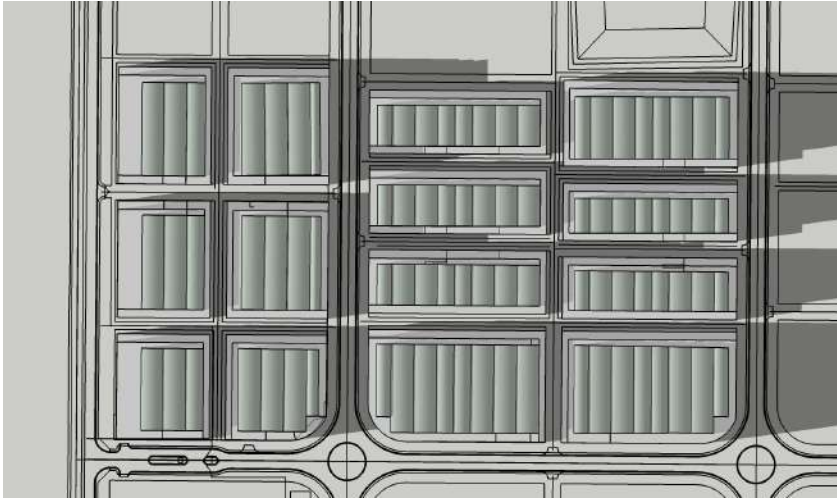
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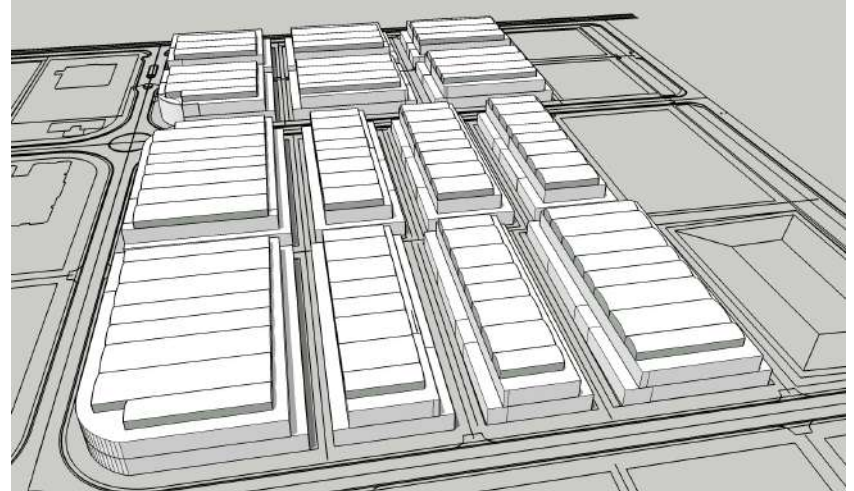
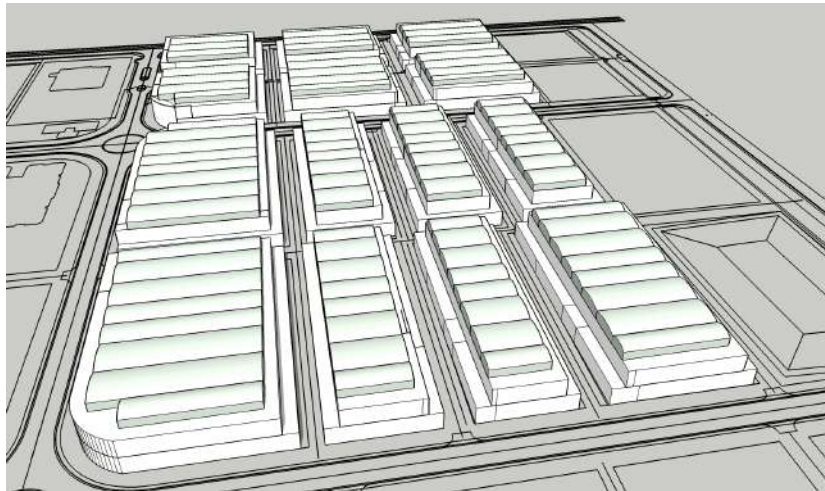
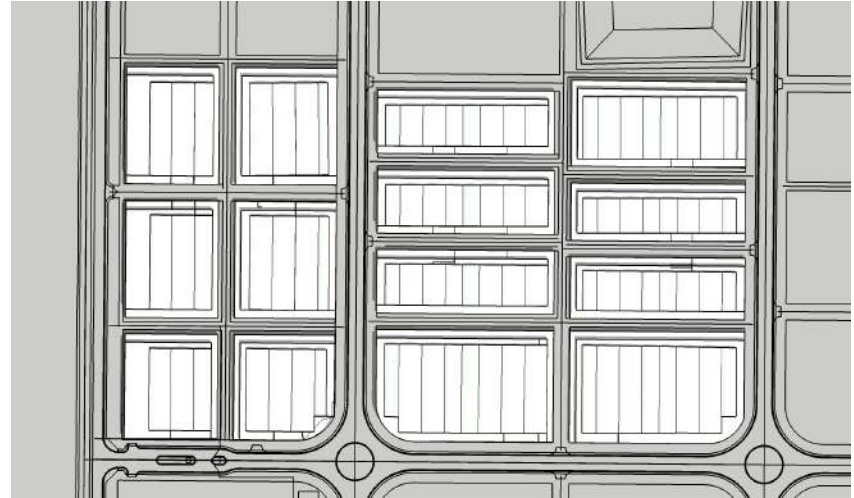
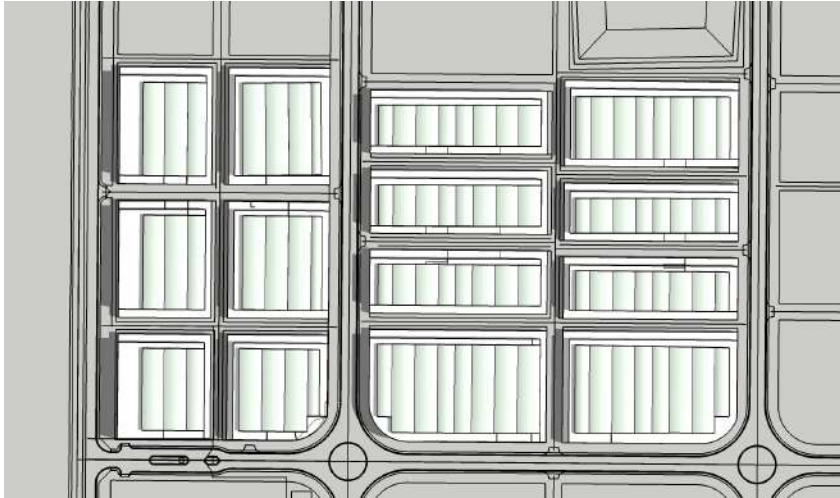
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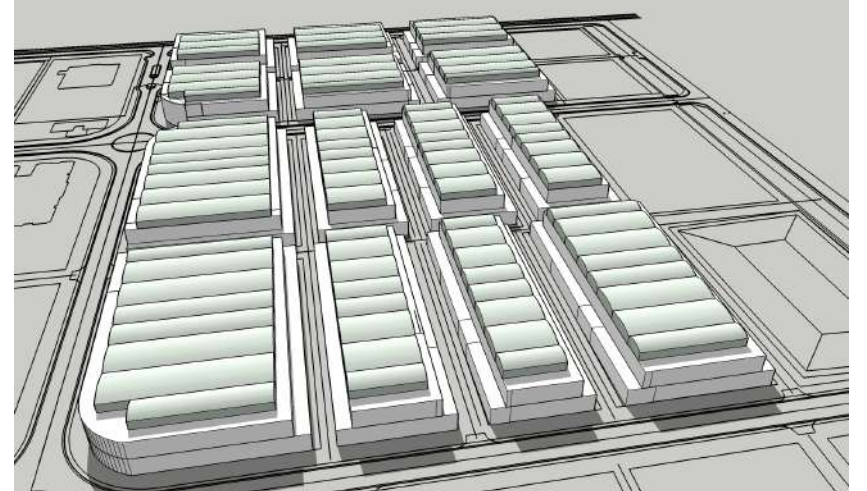
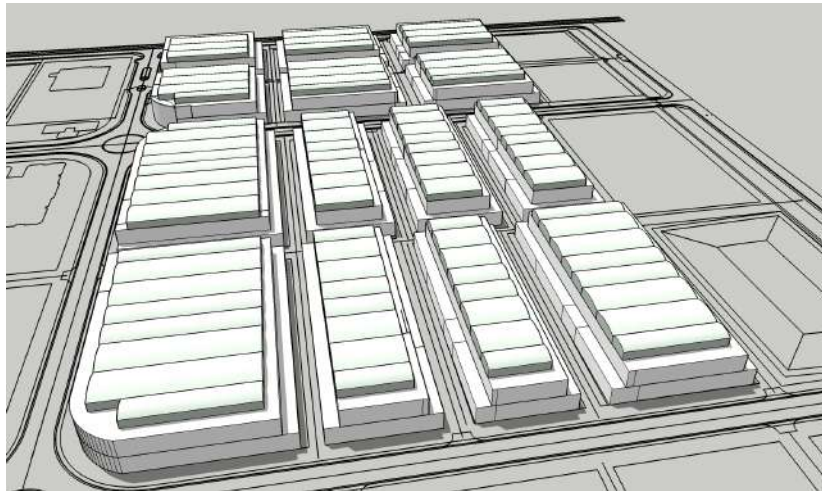
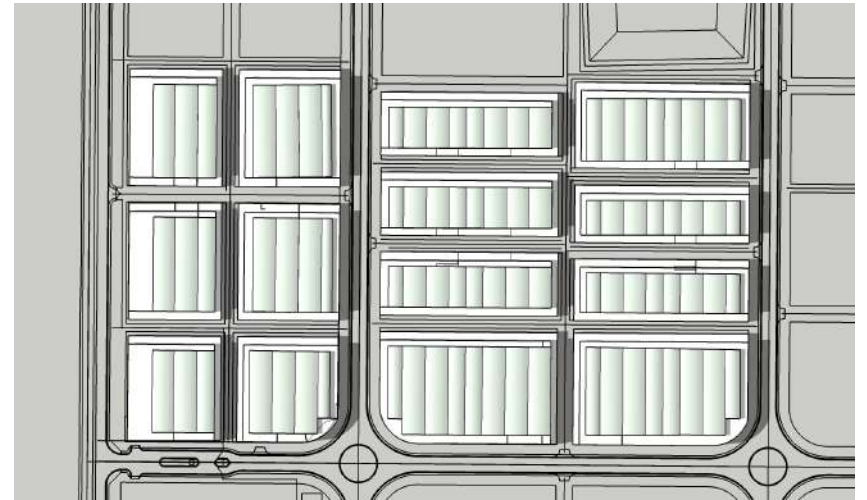
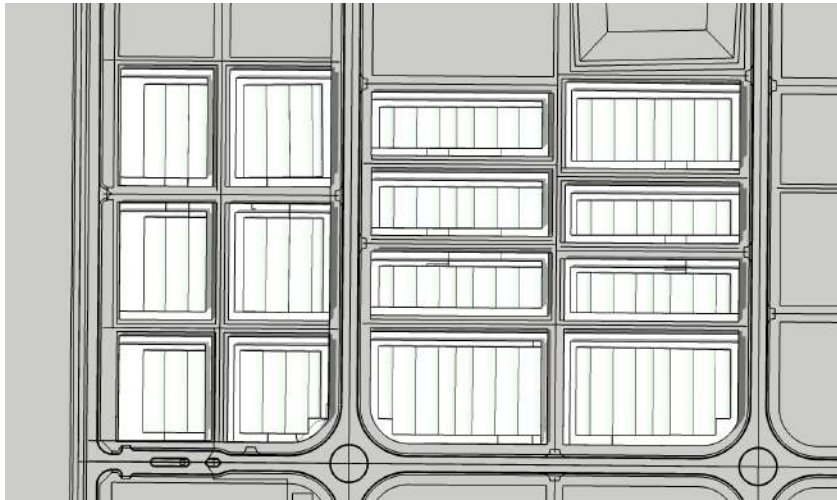
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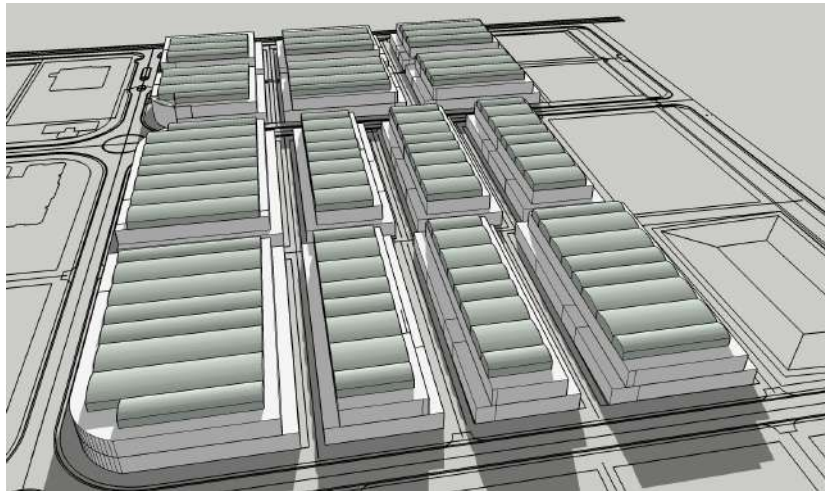
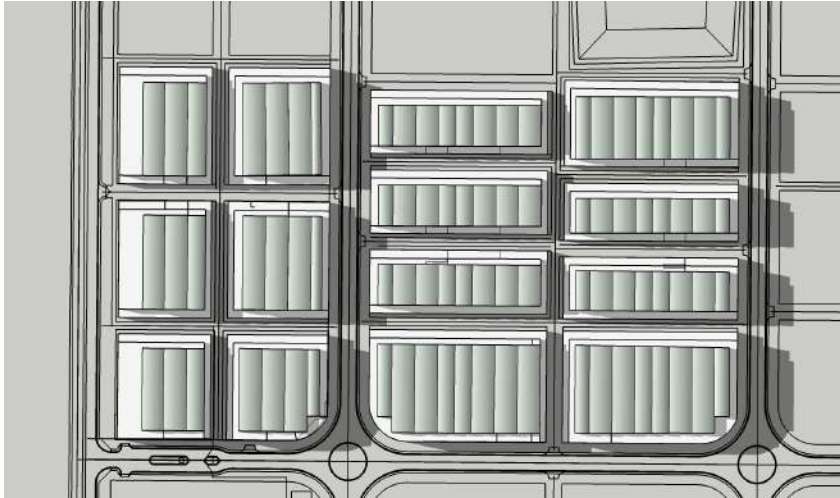
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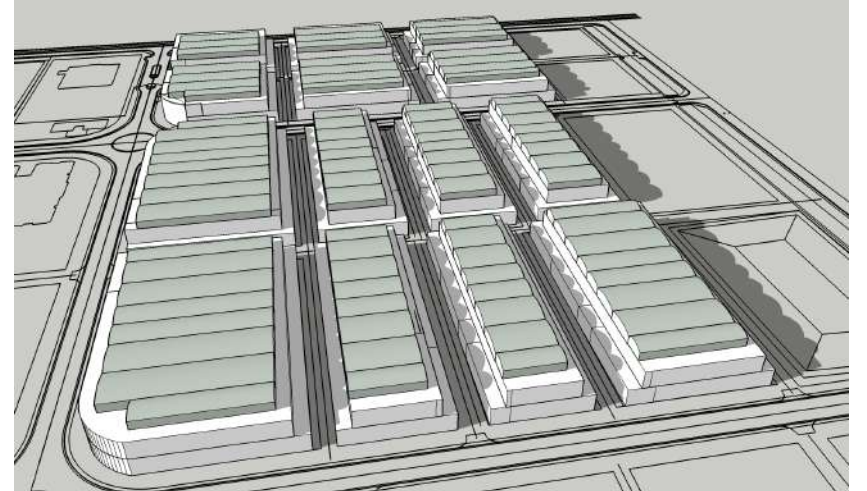
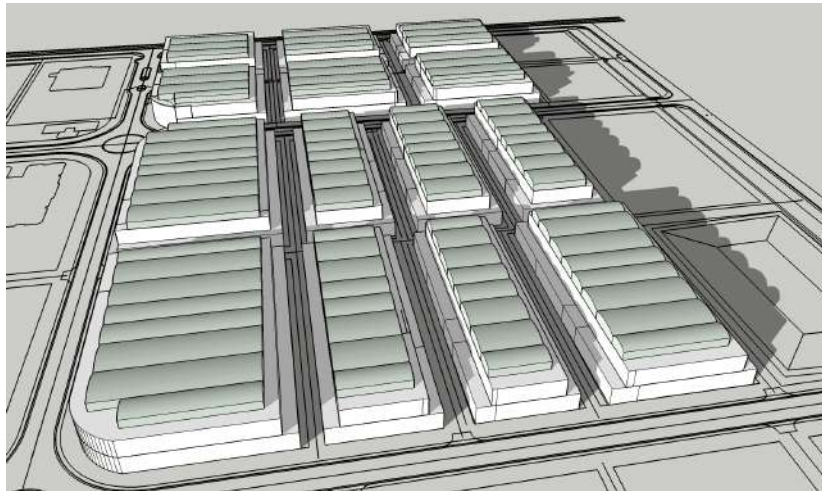
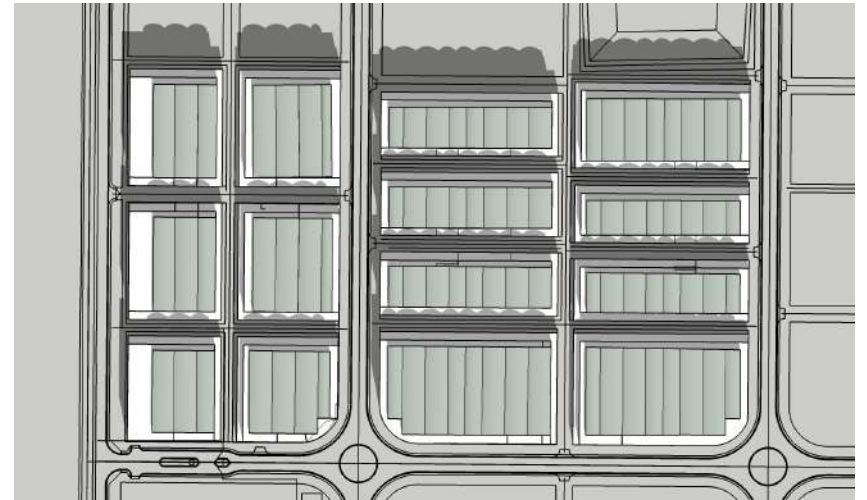
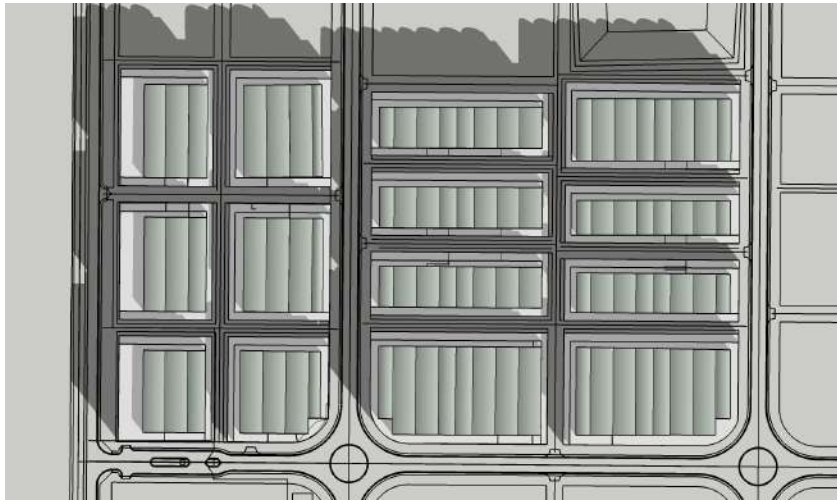
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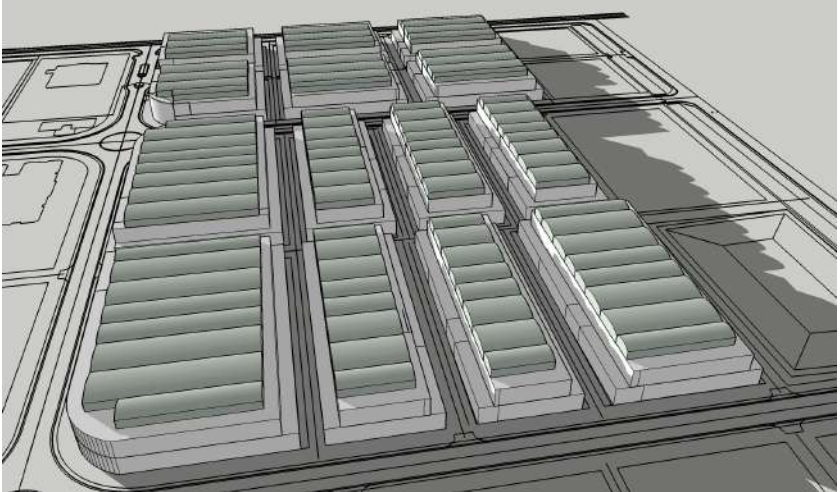
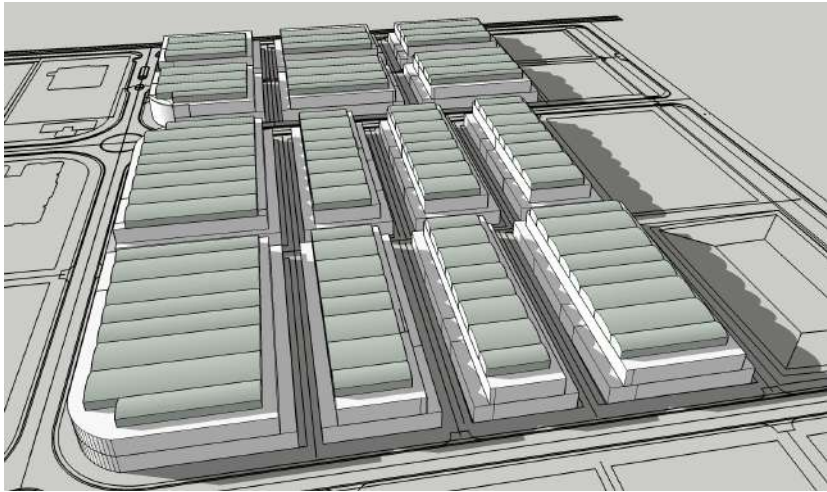
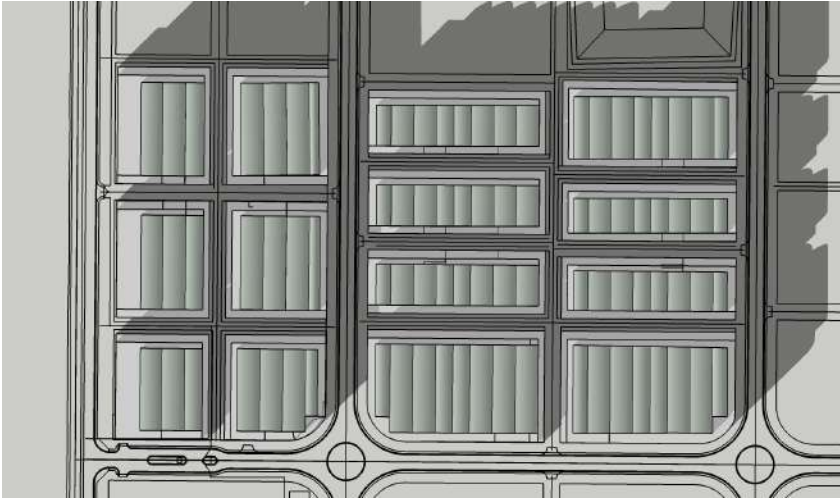
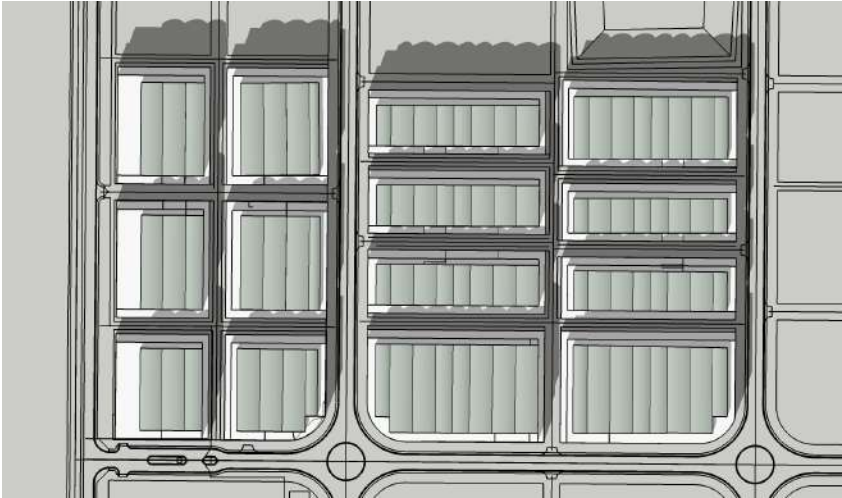
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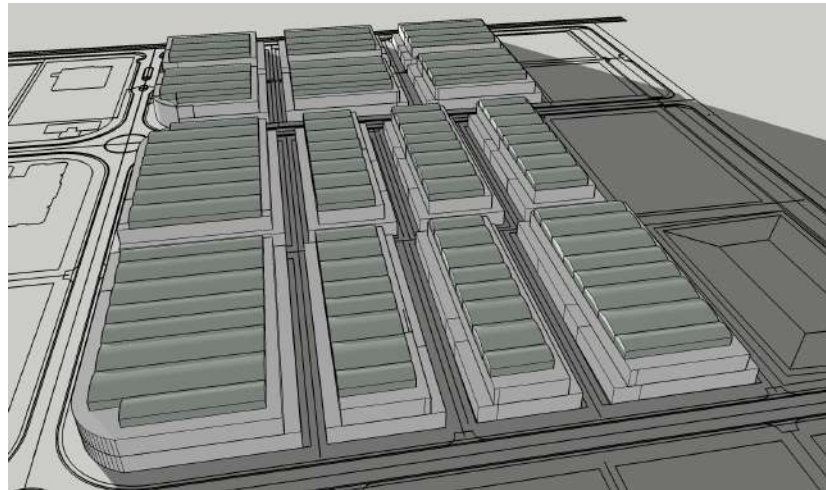
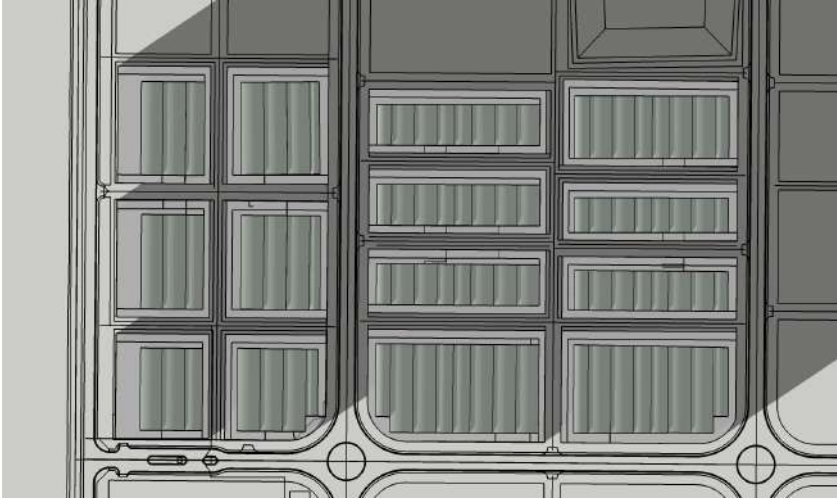
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## DECEMBER 21st- Three Story Buildings



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# APPENDIX G

## VERMICULTURE TECHNOLOGY

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## Vermiculture Technology: Reviving the Dreams of Sir Charles Darwin for Scientific Use of Earthworms in Sustainable Development Programs

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**Keywords:** Vermicomposting of Wastes, Vermifiltration of Wastewater, Vermiremediation of Contaminated Lands, Vermi-Agroproduction of Chemical-Free Organic Foods, Vermicompost—a Nutritive Biofertilizer & Soil Conditioners for Farms, Earthworms Biomass—a Valuable Resource for Pharmaceutical & Consumer Industries, Vermiculture—One Time Investment Technology with Valued By-products and End-products

### Abstract

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Vermiculture technology is emerging as an “environmentally sustainable”, “economically viable” and “socially acceptable” technology all over the world. 1) Vermi-composting Technology (to manage most organic wastes); 2) Vermi-filtration Technology (to treat municipal & several industrial wastewater); 3) Vermiremediation Technology (to treat & clean up contaminated lands); 4) Vermi-agro-production Technology (to produce chemical-free organic foods by worms & vermicompost); 5) Vermi-industrial Production Technology (to produce valuable industrial raw materials from worms). The use of earthworms as “waste managers” for efficient “composting of food and farm wastes” and as “soil managers” for “fertility improvement” and enhanced “farm production” were known for ages but now it is being more scientifically and also commercially revived. The other uses of earthworms for the benefits of environment and society (wastewater treatment, land remediation & production of valuable medicines even to combat cancer and heart diseases; raw materials for rubber, lubricant, soap, detergent & cosmetic, industries and protein rich feed materials for fishery, dairy & poultry industries are some “new discoveries”. We have successfully experimented with the first four technologies for management of “municipal solid wastes”, treatment of “municipal & industrial wastewater”, remediation of “PAHs contaminated soils” and production of “wheat & corn crops” by use of vermicompost at Griffith University, Australia, with excellent results. Wastes are degraded by over 75% faster than conventional systems and compost produced are disinfected, detoxified, richer in nutrients & beneficial soil microbes; BOD loads & TSS of wastewater is reduced by over 95%; PAHs from contaminated soils are removed by over 80% in just 12 weeks; and crops growths are promoted by 30-40% higher as compared to chemical fertilizers. Earthworms are both “protective” & “productive” for environment and society.

## 1. Introduction

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The global scientific community today is searching for a technology which should be “economically viable” (cheaper to be afforded by all nations), “environmentally sustainable” (friendly to the environment—flora, fauna, soil, air & water, with no adverse effect on them) and “socially acceptable” (beneficial to the society with no adverse effect on human health). Vermiculture Technology combines all these virtues and qualities together.

A revolution is unfolding in vermiculture studies (rearing of useful earthworms species) for multiple uses in environmental protection and sustainable development [1-3]. Earthworms have over 600 million years of experience as “ecosystem engineers”. Vermiculture scientists all over the world knew about the role of earthworms as “waste managers”, as “soil managers & fertility improvers” and “plant growth promoters” for long time. But some comparatively “new discoveries” about their role in “wastewater treatment”, “contaminated soil remediation”, and more recently about their potential use in modern medicine for protection of “human health” such as in lowering of blood pressure, thinning of blood and dissolving blood clots for stroke and heart patients, cure for cancer, cure for arthritis & rheumatism, as an anti-inflammatory agent, source of antibiotics and as a rich source of “high quality protein” have brought a revolution in the vermiculture studies.

About 4,400 different species of earthworms have been identified, and quite a few of them are versatile waste eaters and bio-degraders and several of them are bio-accumulators & bio-transformers of toxic chemicals.

## 2. The Biology & Ecology of Earthworms

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Earthworms are long, narrow, cylindrical, bilaterally symmetrical, segmented animals without bones. Usually the life span of an earthworm is about 3 to 7 years depending upon the type of species and the ecological situation. Earthworms harbor millions of “nitrogen-fixing” and “decomposer microbes” in their gut. They have “chemoreceptors” which aid in search of food. Their body contains 65% protein (70-80% high quality “lysine rich protein” on a dry weight basis), 14% fats, 14% carbohydrates and 3% ash [4-6].

Earthworms occur in diverse habitats specially those which are dark and moist. They can tolerate a temperature range between 5°C and 29°C. A temperature of 20°C to 25°C and moisture of 60-75% are optimum for good worm function. Earthworms multiply very rapidly. Studies indicate that they double their number at least every 60-70 days. Given the optimal conditions of moisture, temperature and feeding materials earthworms can multiply by 2<sup>8</sup> i.e. 256 worms every 6 months from a single individual. Each of the 256 worms multiplies in the same proportion to produce a huge biomass of worms in a short time. The total life-cycle of the worms is about 220 days. They produce 300-400 young ones within this life period [7]. Earthworms continue to grow throughout their life.

Earthworms can tolerate toxic chemicals in environment. After the Seveso chemical plant explosion in 1976 in Italy, when a vast area was contaminated with extremely toxic chemical like TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin) several fauna perished except for some species of the earthworms that survived. Earthworms which ingested TCDD contaminated soils were shown to bio-accumulate dioxin in their tissues and concentrate it on average 14.5 fold [8]. Earthworms are also tolerant to moderate salt salinity in soil, but some species like the tiger worms (*Eisenia fetida*) has been found to be highly salt tolerant. In a study made by [9] at the US Department of Energy it was found that replicates with a salt concentration of 15 g/kg of soil (nearly half as salty as seawater), survival ranged from 80%-100%.

## 3. Technologies for Sustainable Development by Use of Earthworms

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Following technologies for sustainable development with environmental protection can be envisaged by the use of useful earthworms species which promises to provide cheaper solutions to several social, economic, environmental & health problems plaguing the human society [3,10].

- 1) “THE VERMI-COMPOSTING TECHNOLOGY” for efficient management of municipal & industrial solid wastes (organics) by biodegradation & stabilization and converting them into useful resource (vermicompost/nutritive biofertilizer);
- 2) “THE VERMI-FILTRATION TECHNOLOGY” for treatment of municipal and some industrial wastewater, their purification & disinfection for reuse;
- 3) “THE VERMI-REMEDIATION TECHNOLOGY” for cleaning up chemically contaminated sites (lands) while also improving their physical, chemical and biological properties for reuse;
- 4) “THE VERMI-AGRO-PRODUCTION TECHNOLOGY” for restoring & improving soil fertility to produce safe and chemical-free food for the society by the use of vermicompost & without recourse to the destructive agro-chemicals;
- 5) “THE VERMI INDUSTRIAL PRODUCTION TECHNOLOGY” for use of earthworms to produce some “bioactive compounds” for pharmaceutical industries and valuable raw materials to be used in rubber, lubricant, soaps, detergent & cosmetics industries and use of rich worm proteins as feed materials to promote fishery, dairy & poultry industries to produce more nutritive foods for the society.

Vermiculture technologies based on earthworms are self-promoted, self-regulated, self-improved & self-enhanced, low or no-energy requiring zero-waste technologies, easy to construct, operate and maintain. They excel all “bio-conversion”, “bio-degradation” & “bio-production” technologies by the fact that they can utilize organics that otherwise cannot be utilized by others. They excel all “bio-treatment” technologies because they achieve greater utilization than the rate of destruction achieved by other technologies. They involve about 100-1000 times higher “value addition” than other biological technologies [11,12].

Technologies based on earthworms are also “environmentally & economically sustainable” as the worms are “highly renewable resources” regenerating at a rapid rate (by 2<sup>8</sup> i.e. 256 worms every 6 months from a single individual & each of the 256 worms multiplying in the same proportion) and the products are completely “biodegradable”. The best part is that application of some vermiculture technologies are based on the by-products (worm biomass & vermicompost) generated in the operation of other technologies and therefore, more sustainable. It is like “killing several birds” in one shot.

#### **4. The Vermicomposting Technology for Efficient Management of Solid Wastes: Diverting Waste from Landfills, and Recovering Resource from Waste**

Waste is a problem of the modern civilized society. We are facing the escalating socio-economic and environmental cost of dealing with current and future generation of mounting municipal solid wastes (MSW). A considerable portion of MSW consist of “Organic Wastes” that are “biodegradable” and can be vermicomposted into a highly “nutritive bio-fertilizer” 4-5 fold more powerful than conventional composts and even superior to chemical fertilizers for better crop growth and safe food production.

Another serious cause of concern today is the emission of greenhouse gases (GHG) methane (CH<sub>4</sub>) & nitrous oxides (N<sub>2</sub>O) resulting from the disposal of MSW either in the landfills or from their management by conventional composting systems. Molecule to molecule CH<sub>4</sub> is 21 times and N<sub>2</sub>O is 310 times more powerful GHG than the CO<sub>2</sub>. Millions of tons of MSW generated from the modern society are ending up in the landfills everyday, creating extraordinary economic and environmental problems for the local government to manage and monitor them (may be up to 30 years) for environmental safety (emission of GHG, toxic gases and leachate discharge into ground water). Construction of secured engineered landfills incurs 20-25 million U.S. dollars before the first load of waste is dumped in 2002-03. Over the past 5 years the cost of landfill disposal of waste has increased from \$ 29 to \$ 65 per ton of waste in Australia. During 2002-2003, waste management services within Australia cost \$ 2458.2 millions.

Waste degradation & composting by earthworms is proving to be economically & environmentally preferred technology over the conventional microbial degradation & composting technology as it is rapid and nearly odorless process, reducing composting time by more than half and the end product is both “disinfected” and “detoxified” [13,14]. On an average, 2000 adult worms weigh 1 kg & one million worms approx. 1 ton. One million worms doubling every two months can become 64 million worms at the end of the year. Considering that each adult worm (particularly *Eisina fetida*) consume waste organics equivalent to its own body weight everyday, 64 million worms (weighing 64 tons) would consume 64 tons

of waste everyday and produce 30-32 tons of vermicompost per day at 40-50% conversion rate.

#### **4.1. Community Wastes That can be Salvaged by Earthworms**

Waste eater earthworms can physically handle a wide variety of organic wastes from both municipal (domestic and commercial) and industrial (livestock, food processing and paper industries) streams [2,13,15].

##### **1) Municipal Organic Wastes**

The food waste from homes (both raw & cooked kitchen wastes—fruits and vegetables, grains & beans, coffee grounds, used tea leaves & bags, crushed egg shells) and restaurants & fried food wastes from fast-food outlets The garden wastes (leaves and grass clippings) also constitute an excellent feed stock for vermi-composting. Grass clippings (high carbon waste) require proper blending with nitrogenous wastes. The “sewage sludge” (biosolids) from the municipal wastewater also provide a good feedstock for the worms. The worms digest the sludge and convert a good part of it into vermi-compost. Paunch waste materials (gut contents of slaughtered ruminants) from abattoir also make good feedstock for earthworms [14,16].

##### **2) Agriculture and Animal Husbandry Wastes**

Farm wastes such as crop residues, dry leaves & grasses. Livestock rearing waste such as cattle dung, pig and chicken excreta makes excellent feedstock for earthworms.

##### **3) Some Industrial Organic Wastes**

Solid waste including the “wastewater sludge” from paper pulp and cardboard industry, food processing industries including brewery and distillery; vegetable oil factory, potato and corn chips manufacturing industry, sugarcane industry, aromatic oil extraction industry. Sericulture industry, logging and carpentry industry also offers excellent feed material for vermi-composting by earthworms [17,18].

#### **4.2. Some Important Studies on Vermicomposting Technology**

1) Reference [6] studied vermicomposting in great details and found that most earthworms consume, at the best, half their body weight of organics in the waste in a day. *Eisenia fetida* can consume organic matter at the rate equal to their body weight every day. Earthworm participation enhances natural biodegradation and decomposition of organic waste from 60 to 80% over the conventional aerobic & anaerobic composting. Given the optimum conditions of temperature (20-30°C) and moisture (60-70%), about 5 kg of worms (numbering approx. 10,000) can vermi-process 1 ton of waste into vermicompost in just 30 days. Upon vermi-composting the volume of solid waste is significantly reduced from approximately 1 cum to 0.5 cum of vermi-compost indicating 50% conversion rate, the rest is converted into worm biomass.

2) References [18-22] studied the degradation and composting of “wastewater sludge” from paper pulp and cardboard industry, brewery and distillery, sericulture industry, vegetable oil factory, potato and corn chips manufacturing industry, sugarcane industry, aromatic oil extraction industry, logging and carpentry industry by earthworms. These organic wastes offer excellent feed materials for vermi-composting by earthworms. Reference [19] also studied the vermicomposting of waste from the mining industry which

contains sulfur residues and creates disposal problems. They can also be fed to the worms mixed with organic matter. Optimum mixing ratio of the sulfur waste residues to the organic matter was 4%.

3) Reference [23] studied the vermicomposting of “fly-ash” from the coal power plants which is considered as a hazardous waste and poses serious disposal problem due to heavy metal contents. As it is also rich in nitrogen and microbial biomass it can be vermi-composted by earthworms. They found that 25% of fly-ash mixed with sisal green pulp, parthenium and green grass cuttings formed excellent feed for *Eisenia fetida* and the vermicompost was higher in NKP contents than other commercial manures. The earthworms ingest the heavy metals from the fly-ash while converting them into vermicompost.

4) Reference [24] successfully studied vermicomposting of “human excreta” (feces). It was completed in six months, with good physical texture, odourless and safe pathogen quality. Sawdust appeared to be the best covering material that can be used in vermicomposting toilets to produce compost with a good earthy smell, a crumbly texture and dark brown colour.

#### 4.3. Our Studies on Vermicomposting Technology at Griffith University, Australia

1) Reference [25] studied the degradation and composting abilities of three species of earthworms on cattle dung, raw food wastes and garden wastes and found that the worm *Eudrilus euginae* was a better waste degrader followed by *Eisenia fetida*.

2) Reference [26] studied the vermicomposting of “sewage sludge” (biosolids). In 12 weeks study period there were no significant changes in the control. Most significant and rapid changes were observed in sludge which contained earthworms. Foul odor disappeared by week 2 and by week 12, the black and brittle sludge became a homogenous and porous mass of brown vermicast with light texture. Upon chemical analysis, the vermicomposted sludge was over 80% free of heavy metals cadmium (Cd) and lead (Pb) and almost completely free of any pathogens.

3) Reference [27] studied the efficiency of earthworms in degradation and vermicomposting of mixed food & garden wastes and compared with conventional aerobic composting without worms. Degradation of food wastes had started within hours (5% after 24 hours) and were degraded 100% in just 15 days while garden wastes in 60 days. In wastes where the primary cellulosic materials were intact e.g. leaves and grasses, raw vegetables & fruits or where there are brittle calcium compounds e.g. egg shells, were degraded rather more slowly by the earthworms. In the conventional composting system without worms, maximum degradation of both food & garden wastes were only 35% even after 90 days.

#### 4.4. Mechanism of Worm Action in Vermicomposting

Earthworms act as an aerator, grinder, crusher, chemical degrader and a biological stimulator and degrade waste by multiple actions.

##### 1) Grinding action

The waste feed materials ingested is finely ground (with the aid of stones in their muscular gizzard) into small particles to a size of 2-4 microns and passed on to the intestine for enzymatic actions. The gizzard and the intestine work as a “bioreactor”;

## 2) Enzymatic action

The gizzard and the intestine work as a “bioreactor”. Worms secrete enzymes proteases, lipases, amylases, cellulases and chitinases in their gizzard and intestine which bring about rapid biochemical conversion of the cellulosic and the proteinaceous materials in the waste organics. They ingest the food materials, cull the harmful microorganisms, and deposit them mixed with minerals and beneficial microbes as “vermicasts” in the soil [28].

## 3) Worms Reinforce Decomposer Microbes & Act Synergistically

Worms promote the growth of “beneficial decomposer microbes” (bacteria, actinomycetes & fungi) in waste biomass [28,29]. They host millions of decomposer microbes in their gut which is described as “little bacterial factory”. They devour on microbes and excrete them out (many times more in number than they ingest) in soil along with nutrients nitrogen (N) and phosphorus (P) in their excreta. The nutrients N and P are further used by the microbes for multiplication and vigorous action [30]. Reference [31] showed that the number of bacteria and “actinomycetes” contained in the ingested material increased up to 1000 fold while passing through the gut. A population of worms numbering about 15,000 will in turn foster a microbial population of billions of millions. Earthworms and microbes act “sybiotically & synergistically” to accelerate and enhance the decomposition of the organic matter in the waste. It is the microorganisms that break down the cellulose in the food waste, grass clippings and the leaves from garden wastes [32].

## 4) Humification

The final process in vermi-processing and degradation of organic matter is the “humification” in which the large organic particles are converted into a complex amorphous colloid containing “phenolic” materials. About one-fourth of the organic matter is converted into humus. Humus is essential in soil for plant growth & survival. It takes several years in conventionally produced compost to generate “humus” through slow disintegration, whereas, earthworms excrete “humus” in its compost.

### 4.5 Advantages of Vermicomposting Technology

#### 1) Salvage Human Wastes & Divert Huge MSW from Landfills

A big advantage of great economic & environmental significance is that production of vermicompost from “organic wastes” divert huge amount of MSW from ending up in the landfills thus also saving cost on waste disposal and reducing discharge of toxic leachate and gases and emission of greenhouse gases (GHG) which occurs from waste landfills.

#### 2) Rapid and Efficient Process & Takes Half the Time than the Conventional System

Earthworms have the real potential to accelerate and enhance the natural biodegradation and decomposition of organic materials from 60 to 80% by promoting the growth of “beneficial decomposer aerobic bacteria” in the waste biomass. They host millions of decomposer microbes in their gut and also act as an aerator, grinder, crusher, chemical degrader and a biological stimulator [25]. As compared to the conventional composting systems, it takes nearly half the time to convert waste into vermicompost and the process becomes faster with time as the degrader worms and microbes multiply in number. Given the optimum conditions of temperature and moisture, about 1/2 kg of adult worms (approx. 1000) or 5 kg of worms (approx. 10,000) can vermicompost 10 kg of waste or 1 ton of waste respectively in just 30 days [6].

### 3) Earthworms Disinfect, Detoxify and Add Value to the End Products

Vermicomposting excels all conventional composting systems by the fact that it can utilize organics that otherwise cannot be utilized by others and achieves greater “utilization” than the rate of “destruction” achieved by others and also involves about 100-1000 times higher “value addition” than other technologies [33]. Another matter of considerable significance is that the earthworms stabilize the organic residues in the waste removing any “harmful pathogens” and “toxic chemicals” from the compost. They partially “detoxify” and “disinfect” the end product which is nearly “odorless” [34]. Several studies have found that earthworms effectively bio-accumulate or biodegrade several organic and inorganic chemicals including “heavy metals”, “organochlorine pesticide” and “polycyclic aromatic hydrocarbons” (PAHs) residues in the medium in which it inhabits [26]. The quality of vermicompost is significantly better, rich in key minerals & beneficial soil microbes. In fact in the conventional composting technology which is thermophilic (temperature rising up to 55°C) many beneficial microbes are killed and nutrient especially nitrogen is lost (due to gassing off of nitrogen). The end product is more homogenous, richer in “plant-available nutrients & humus” and significantly low contaminants. They are “soft”, “highly porous” with greater “water holding capacity” [1,11,35].

### 4) No or Low Energy Use in Vermi-composting Process

Normal microbial composting requires energy for aeration (constant turning of waste biomass and even for mechanical airflow) and sometimes for mechanical crushing of waste to achieve uniform particle size. Vermi-composting does not involve such use of energy. Earthworms aerate the system constantly by burrowing actions.

### 5) Generate No or Low Odor

Earthworms create aerobic conditions in the waste materials by their burrowing actions, inhibiting the action of anaerobic micro-organisms which release foulsmelling hydrogen sulfide and mercaptans.

### 6) Low Greenhouse Gas Emissions in MSW Disposal

High volumes of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxides (N<sub>2</sub>O) is emitted from the conventional composting process especially in anaerobic conditions. Worms significantly increase the proportion of “aerobic to anaerobic decomposition” in the compost pile by “burrowing and aerating action” leaving very few anaerobic areas in the pile, and thus significantly reducing emission these gases and also volatile sulfur compounds. Analysis of vermicompost samples has shown generally higher levels of available nitrogen (N) as compared to the conventional compost samples made from similar feedstock. This implies that the vermicomposting process by worms is more efficient at retaining nitrogen (N) rather than releasing it as nitrous oxide (N<sub>2</sub>O).

Our study found that on average the anaerobic composting systems emitted the highest amount of CO<sub>2</sub> (2950 mg/m<sup>2</sup>/hour) and CH<sub>4</sub> (9.54 mg/m<sup>2</sup>/hour), while the aerobic systems (both with and without worms) emitted the least amount of CO<sub>2</sub> (880 mg/m<sup>2</sup>/hour) and CH<sub>4</sub> (2.17 mg/m<sup>2</sup>/hour). Vermicomposting systems had the “lowest emission” of N<sub>2</sub>O which is most powerful GHG [2,36].

## 4.6. Global Movement for Vermicomposting MSW to Divert Waste from Landfills

Large scale vermicomposting of MSW including the “sewage sludge” on commercial scale is a movement going on to divert solid waste from ending up in the landfills [37]. Municipal councils and composting companies are also participating in vermicomposting business, composting all types of organic wastes on commercial scale and selling them to the

farmers. This has dual benefits. Cutting cost on landfill disposal of waste while earning revenues from sale of worms & vermicompost [1,10,38]. First serious experiments for management of municipal/industrial organic wastes were established in Holland in 1970, and subsequently in England, and Canada. Later vermiculture were followed in USA, Italy, Philippines, Thailand, China, Korea, Japan, Brazil, France, Australia, Israel & Russia.

1) USA: U.S. has some largest vermicomposting companies and plants in world and States are encouraging people for “backyard vermicomposting” to divert wastes from landfills [39]. The American Earthworm Company started a “vermi-composting farm” in 1978-79 with 500 t/month of vermicompost production [40]. A farm in LA rears 1,000,000 worms to treat 7.5 tons of garbage each month. Nearly 300 large-scale vermiculturist formed an “International Worms Growers Association” in 1997 and is having booming business. Vermicycle Organics produced 7.5 million pounds of vermicompost every year in high-tech greenhouses. Its sale of vermicompost grew by 500% in 2005. Vermitechnology Unlimited has doubled its business every year since 1991 [41,42].

US scientists are also searching for life-saving “vermimedecines” from the bioactive compounds in earthworms [43].

2) Canada: Canada is also ahead in vermicomposting business on commercial scale for both “vermicompost” and “vermimmeal” production. Large-scale vermicomposting plants have been installed at several places to vermicompost municipal and farm wastes and their use in agriculture [44]. An “Organic Agriculture Centre of Canada” has been established whose objective is to replace “Chemical Agriculture” by Vermiculture [38].

3) UK: UK is also following US and Canada in promoting vermiculture mainly for waste management and to reduce the needs of “waste landfills”. Large 1000 metric ton vermicomposting plants have been erected in Wales to compost diverse organic wastes [45].

4) France: France is also promoting vermiculture on commercial scale to manage all its MSW and reduce the needs of landfills. About 20 tons of mixed household wastes are being vermi-composted everyday using 1000 to 2000 million red tiger worms (*Eisenia andrei*) [6].

5) New Zealand: It is also a leading nation in vermiculture. The Envirofert Company of New Zealand is vermicomposting thousands of tons of green waste every year. They put the green waste first to a lengthy thermophilic cooking, and then to vermicomposting by worms after cooling. Cooking of green waste help destroy the weeds and pathogens which may come from the feces of pets in grasses. They claim that each worm eat the cooked green waste at least 8 times leaving an end product rich in key minerals, plant growth hormones, enzymes, and beneficial soil microbes. Envirofert is also planning to vermicompost approximately 40,000 tones of food wastes from homes, restaurants and food processing industries every year ([www.envirofert.co.nz](http://www.envirofert.co.nz)) [45,46].

6) Australia: Vermicomposting is being done on large scale in Australia as a part of the “Urban Agriculture Development Program” utilizing the urban solid wastes [1]. The Sydney Waters in New South Wales have set up a vermiculture plant of 40 million worms to degrade up to 200 ton of urban wastes a week. The Gayndah Shire Council in Queensland, Australia, is vermi-composting over 600 tons of organic waste into valuable organic fertilizer (vermi-compost) and selling to the local farmers. Vermicomposting of sludge from the sewage and water treatment plants is being increasingly practiced in Australia and as a result it is saving over 13,000 cum of landfill space every year in Australia [47]. The Hobart City Council in Tasmania, vermicompost and stabilize about 66 cum of sewage sludge every week.

7) India: India also launched vermicomposting program of MSW in the 1990s and and Bhawalkar Earthworms Research Institute (BERI) in Pune were among the pioneer institutions. Tata Energy Research Institute (TERI) in Delhi is also doing commendable works. In recent years it is growing as a part of “sustainable non-chemical agriculture” program combined with “poverty eradication” program. Farmers are using vermicompost on large scale and a revolution is going on. Vermicomposting business has enhanced the lives of poor in India and generated self-employment opportunities for the unemployed. In several Indian villages NGO’s are freely distributing cement tanks and 1000 worms and encouraging men and women to collect waste from villages and farmers, vermicompost them and sell both worms and vermicompost to the farmers. People are earning from Rupees 5 to 6 lakhs (Approx. AU \$ 15-20 thousands) every year from sale of both worms and their vermicompost to the farmers. Mostly they use farm waste and also MSWs collected from streets and waste dumpsites [48,49].

Bihar, Karnataka, Tamil Nadu, Gujarat and Maharashtra are leading states in vermiculture revolution. The Karnataka Compost Development Corporation established a first

vermicomposting unit in the country to handle all municipal urban solid wastes and is producing 150 to 200 tons of vermicompost every day from city garbage [50]. She has listed several farmers whose life has been changed from a poor “farm labourer” to a “rich farmer” who embraced vermiculture.

8) Philippines: Vermiculture and vermicomposting were introduced in the Philippines in the 1970s. Vermicompost is being used by farmers on large scale replacing the chemical fertilizers. Recently, commercial production of “vermimmeal” from earthworms biomass has been started as a substitute to “fishmeal” for promoting fishery industries [51].

9) Argentina: Vermiculture is an expanding business in Argentina especially for the development of rural and farming communities. “Worms Argentina” is a growing company which reports to be exporting “composting worms” on large scales to European, South American, Caribbean and Middle East nations. They are in high demands from Middle East countries for recycling of polluting dairy effluents [52].

10) China: Vermiculture is a fast growing industry in China for the development of rural communities. It is in fact “revival” of the traditional culture practiced by ancient medicinemen who used earthworms for treatment of several diseases. Earthworms are now being used for vermicomposting of “waste”, promoting “organic farming” and for the development of “vermi-medicines” and “nutritive vermimeals”. A dietary supplement in the name of PLASMIN is being marketed in China [42,53, 54].

11) Russia: Vermiculture is being promoted on large scale in Russia for management of MSW and development of life-saving “vermi-medicines” from the worms for treatment of human diseases for which conventional medicine do not have an answer. Scientists have developed a special breed of the versatile species Eisenia fetida which can tolerate and survive in cold climates [55].

12) Japan: Japan is also promoting vermiculture since 1970s mainly for management of MSW and production of worm biomass to isolate “bioactive compounds” for production of “vermi-medicines” [12,56].

## **5. The Vermifiltration Technology for Wastewater Treatment, Disinfection & Detoxification for Reuse**

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We are also facing the escalating socio-economic and environmental cost of dealing with current and future generation of mounting municipal and industrial wastewater. Over 80% of the potable water used by society return as wastewater. Conventional treatment results into formation of “sludge” which requires safe disposal in “secured landfills” at additional cost.

Vermifiltration of wastewater using waste eater earthworms is a newly conceived novel technology with several advantages over the conventional systems. Earthworms body work as a “biofilter” and they have been found to remove the 5 days biological oxygen demand (BOD<sub>5</sub>) by over 90%, chemical oxygen demand (COD) by 80-90%, total dissolved solids (TDS) by 90-92% and the total suspended solids (TSS) by 90-95% from wastewater by the general mechanism of “ingestion” and biodegradation of organic wastes and also by their “absorption” through body walls. Suspended solids are trapped on top of the vermifilter and processed by earthworms and fed to the soil microbes immobilized in the vermifilter. Worms also remove chemicals including heavy metals and pathogens from treated wastewater [57] and the treated water becomes fit for “reuse” in non-potable purposes.

### **5.1. Some Important Studies on Vermifiltration Technology**

1) Reference [58] studied the use of earthworm for the management of effluents from intensively housed livestock which contain very heavy loads of BOD, TDSS and nutrients nitrogen (N) and phosphorus (P). The worms produced clean effluents and also nutrient rich vermicompost.

2) Reference [59] studied the treatment of domestic wastewater using vermifilter beds and concluded that worms can reduce BOD and COD loads as well as the TDSS (total dissolved and suspended solids) significantly by more than 70-80%.

3) Reference [60] studied the vermifiltration of municipal wastewater in a pilot plant for treating wastewater of 1000 inhabitants and found that the BOD load was removed by 99%, TSS by 95%, VSS (volatile suspended solids) by 96%, nitrogen (N) by 89% and phosphorus (P) by 70%. The vermifilter bed was prepared of stones at the bottom and sawdust above with 20-30 cm humus at the top in which 5000-10,000 earthworms (*Eisenia andrea*) per square meter was released. *E. coli* (M.P.N.) was removed by 1000 fold. Such systems allowed to treat 1000 L/m<sup>2</sup> of wastewater per day. They have commercialized and patented the technology in Chile.

4). A pilot study on vermifiltration of sewage was made by [61] at Shanghai Quyang Wastewater Treatment Facility in China. The earthworm bed which was 1 m (long) × 1 m (wide) × 1.6 m (high), was composed of granular materials and earthworms. The worm's number was kept at about 8000 worms/sqm. The average chemical oxygen demand (COD) value of raw sewage used was 408.8 mg/L that of 5 days biological oxygen demand (BOD<sub>5</sub>) was 297 mg/L that of suspended solids (SS) was 186.5 mg/L. The hydraulic retention time varied from 6 to 9 hours and the hydraulic loading from 2.0 to 3.0 m<sup>3</sup>/ (m<sup>2</sup>.d) of sewage. The removal efficiency of COD ranged between 81-86%, the BOD<sub>5</sub> between 91-98%, and the SS between 97-98%.

## 5.2. Our Studies on Vermifiltration Technology at Griffith University, Australia

1) Reference [62] studied the vermifiltration of sewage obtained from the Oxley Wastewater Treatment Plant in Brisbane, Australia. Results showed that the earthworms removed BOD (BOD<sub>5</sub>) loads of sewage by over 99% at hydraulic retention time (HRT) of 1-2 hours. Average COD removed from the sewage was over 50%. Although the COD removal by vermifiltration system was not significant like BOD, it was still higher than the value of COD removed by the control system without worms. This clearly signifies the role of earthworms in the degradation of “complex chemicals” in wastewater to reduce the Chemical Oxygen Demand. Earthworms also removed the total suspended solids (TSS) from the sewage by over 90%. More significant was that there was “no formation of sewage sludge”.

2) Reference [63] also studied the vermifiltration of brewery and milk dairy wastewaters in Brisbane which have very high BOD<sub>5</sub> and TSS loadings e.g. 6780 mg/L & 682 mg/L respectively from brewery and 1,39,200 mg/L & 3,60,00 mg/L respectively from the dairy industry. Earthworms removed the high BOD<sub>5</sub> loads by 99% in both cases and TSS by over 98%. But the hydraulic retention times (HRTs) in case of brewery wastewater was 3-4 hours and 6-10 hours for the dairy wastewater.

An important observation was that the control system (devoid of earthworms) frequently got choked. The organic solids in the wastewater accumulated as peat in the soil layer and also attracted heavy “fungal infection”. It became un-operational after sometimes. In the vermifiltration system the earthworms constantly fed upon the solids and the fungus and never allowed the system to be choked and become un-operational.

3) Currently Reference [64] are working on vermifiltration of wastewater from “fruit juice processing industry” in Brisbane. The fruit juice wastewater contain very high BOD, COD, TSS and TDS loads. The initial 5 days biological oxygen demand (BOD<sub>5</sub>) was reduced from 1340 ppm to 3 ppm (99.77%), chemical oxygen demand (COD) from 2730 ppm to 112 ppm (95.89%), total suspended solids (TSS) from 190 ppm to 16 ppm (91.57%), total dissolved solids (TDS) from 440 ppm to 12 ppm (97.27%), and the turbidity from 130 NTU (naphelometric units) to 6 NTU (95.38%). The vermifiltration system (vermifilter bed) contained a 4 inches layer of vermicompost (humus) and on the top of it a 6 inches layer of soil containing 450-500 “adult healthy earthworms” (*Eisenia fetida*) @ 5000 worms per cubic meter of soil.

## 5.3. The Mechanism of Worm Action in Vermifiltration

The twin processes of microbial stimulation & biodegradation, and the enzymatic degradation of waste solids by worms simultaneously work in the vermifiltration system. Vermifilters provide a high specific area—up to 800 sq m/g and voidage up to 60%. Suspended solids are trapped on top of the vermifilter and processed by earthworms and fed to the soil microbes immobilized in the vermifilter.

Intensification of soil processes and aeration by the earthworms enable the soil stabilization and filtration system to become effective and smaller in size. Earthworms intensify the

organic loadings of wastewater in the vermifilter soil bed by the fact that it granulates the clay particles thus increasing the “hydraulic conductivity” of the system. They also grind the silt and sand particles, thus giving high total specific surface area, which enhances the ability to “adsorb” the organics and inorganic from the wastewater passing through it.

Earthworms vermicompost in the vermifilter beds provides wonderful sites for “adsorption” of heavy metals and pollutants in wastewater due to presence of “lignin” contents. The vermicast in the soil bed also offers excellent hydraulic conductivity of sand (being porous like sand) and also high adsorption power of clay [48].

#### 5.4. Advantages of Vermifiltration Technology over the Conventional Wastewater Treatment Technologies

##### 1) Low Energy Requirement

Vermi-filtration of wastewater is low energy & efficient system and has distinct advantage over all the conventional wastewater treatment systems—the “Activated Sludge Process”, “Trickling Filters” and “Rotating Biological Contactors” which are highly energy intensive, costly to install and operate and do not generate any income. In the vermifilter process there is 100% capture of organic materials, the capital and operating costs are less, and there is high value added end products e.g. vermifiltered “nutrient rich” water with potential for farm irrigation and vermicompost retrieved from the vermifiltered beds.

##### 2) No Formation of Sewage Sludge and No Foul Odor

Since the conventional technologies are mostly the flow-processes and have finite hydraulic retention time (HRT) it always results into a “residual stream” of complex organics and heavy metals (while only the simple organics are consumed by decomposer microbes) in the form of “sludge”. This plagues most municipal councils in world as the sludge is a “biohazard” and requires safe landfill disposal at high cost. The greatest advantage of vermifiltration system is that there is no formation of “sewage sludge” [65]. The worms decompose the organics in the wastewater and also devour the solids (which forms the sludge) synchronously. There is no foul odor as the earthworms arrests rotting and decay of all putrescible matters in the wastewater and the sludge. In all developed nations a “worm farm” has become a necessity in all wastewater & water treatment plants to resolve the sludge problems. Earthworms feed readily upon the sludge components, rapidly convert them into vermicompost, reduce the pathogens to safe levels and ingest the heavy metals [26].

##### 3) Detoxified and Disinfected Treated Water for Reuse

Vermifiltered wastewater is free of pathogens and toxic chemicals (heavy metals & endocrine disrupting chemicals) and suitable for “reuse” as water for farm irrigation. & other non-potable uses. The worms devour on all the pathogens (bacteria, fungus, protozoa & nematodes) in the medium in which they inhabit. They have the capacity to bio-accumulate high concentrations of toxic chemicals in their tissues and the resulting wastewater becomes almost chemical-free. Earthworms have also been reported to bio-accumulate “endocrine disrupting chemicals” (EDCs) from sewage which otherwise is not removed by our conventional sewage treatment plants (STPs). Reference [66] have reported significantly high concentrations of EDCs (dibutylphthalate, dioctylphthalate, bisphenol-A and 17 b-estradiol) in tissues of earthworms (*E. fetida*) living in sewage percolating filter beds and also in garden soil.

#### 5.5. Vermifiltration Technology: Destined to Become a Global Movement

Due to its simplicity and cost-effectiveness vermifiltration of both municipal and industrial wastewater is destined to become a global movement. In Chile, over 100 sewage treatment plants of different sizes, going from individual houses to plants for 12,000 persons and bigger plants for industries are already working. It has been introduced on commercial scale in Mexico and Venezuela [60]. India and Brazil is also introducing the technology on commercial scale. Some companies in Pune (India) have already started pilot plants.

If a vermifilter bed of 0.3 cum soil is prepared with approximately 5000 worms (over 2.5 kg) to start with, it can easily treat 950-1000 L of domestic wastewater/ sewage generated by (on an average) a family of 4 people with average BOD value ranging between 300-400 mg/L, COD 100-300 mg/L, TSS, 300-350 mg/L everyday with hydraulic retention time (HRT) of the wastewater in the vermifilter bed being approximately 1-2 hours. Given that the worms multiply and double its number in at least every 60 days under ideal conditions of temperature and moisture, even starting with this number of earthworms a huge population (biomass) of worms with robust vermi-filtration system can be established quickly within few months which will be able to treat greater amount of wastewater generated in the family. An important consideration is the peak hour wastewater generation which is usually very high and may not comply with the required HRT (1-2 hrs) which is very critical for sewage treatment by vermi-filtration system. To allow 1-2 hrs HRT in the vermifilter bed an onsite domestic wastewater storage facility will be required from where the discharge of wastewater to the vermifilter tank can be slowly regulated through flow control.

## **6. Vermiremediation Technology for Cleanup of Chemically Contaminated Lands & Soil for Re-Use & Re-Development**

Large tract of arable land is being chemically contaminated due to mining activities, heavy use of agrochemicals in farmlands, landfill disposal of toxic wastes and other developmental activities like oil and gas drilling. Traditionally, remediation of chemically contaminated soils involves “off-site” management by excavating and subsequent disposal by burial in secured landfills. This method of remediation is very costly affair and merely shifts the contamination problem elsewhere. Additionally, this involves great risk of environmental hazard while the contaminated soils are being transported and “migration of contaminants” from landfills into adjacent lands and water bodies by leaching. Soil washing for removing inorganic contaminants from soil is another alternative to landfill burial, but this technique produce a “residue” with very high metal contents which requires further treatment or burial.

Since the late 1980s, after the chemical and mechanical treatments of lands and water bodies and thermal treatment (incineration) of hazardous wastes proved economically and environmentally unsustainable, focus shifted towards the biological methods which are cost-effective as well as environmentally sustainable and also socially acceptable.

Vermiremediation (using chemical tolerant earthworm species) is emerging as a low-cost and convenient technology for cleaning up the chemically polluted/contaminated sites/ lands in world. Earthworms have been used for land recovery, reclamation and rehabilitation of suboptimal soils such as poor mineral soils, polder soils, open cast mining sites, closed landfill sites and cutover peat [67,68].

### **6.1. Some Important Studies on Vermiremediation Technology**

#### **1) Studies on Removal of Heavy Metals**

Reference [69] studied that earthworms can bio-accumulate high concentrations of heavy metals like cadmium (Cd), mercury (Hg), lead (Pb) copper (Cu), manganese (Mn), calcium (Ca), iron (Fe) and zinc (Zn) in their tissues without affecting their physiology and this particularly when the metals are mostly non-bioavailable. They can particularly ingest and accumulate extremely high amounts of zinc (Zn), lead (Pb) and cadmium (Cd). Cadmium levels up to 100 mg per kg dry weight have been found in tissues. Ireland (1983) reported that the earthworms species *Lumbricus terrestris* can bio-accumulate in their tissues 90-180 mg lead (Pb)/gm of dry weight, while *L. rubellus* and *D. rubida* it was 2600 mg /gm and 7600 mg/gm of dry weight respectively. Zinc (Zn), manganese (Mn), and iron (Fe) were shown to be excreted through the calciferous glands of earthworms. Contreras-Ramos et al. (2005) also confirmed that the earthworms reduced the concentrations of chromium (Cr), copper (Cu), zinc (Zn) and lead (Pb) in the vermicomposted sludge (biosolids) below

the limits set by the USEPA in 60 days.

## 2) Studies on Removal of Polycyclic Aromatic Hydrocarbons (PAH's)

PAHs are priority pollutants and cause great concern with respect to human health and environment. They are inherently “recalcitrant hydrocarbons”, and the higher molecular weight PAHs are very difficult to remediate. Reference [70] studied the influence of earthworms species *L. rubellus* on the disappearance of spiked PAHs phenanthrene & fluoranthene (100 µg/kg of soil) and found that the losses of both PAHs occurred at a faster rate in soils with earthworms, than the soil without worms. After 56 days (8 weeks), 86% of the phenanthrene was removed. Reference [71] studied the uptake of three PAHs viz. phenanthrene, anthracene and benzo(a)pyrene at different concentrations by *E. fetida* and found that the concentration of anthracene decreased by 2-fold after addition of earthworms, benzo(a)pyrene decreased by 1.4-fold and phenanthrene was completely removed (100%) by earthworms

## 3) Studies on Removal of Petroleum and Crude Oil Hydrocarbons

References [72] & [73] studied earthworm species *E. fetida* with varying organic wastes to an oil contaminated soil and found that worms significantly degraded and decreased oil contents in comparison to the control. Reference [74] also studied the use of earthworms *E. fetida* and vermicomposting in the treatment of high molecular weight hydrocarbons “asphaltenes” from the Prestige Oil Spill. Earthworms mineralized the asphaltenes thus eliminating it from the system.

## 4) Studies on Removal of Agrochemicals

Studies indicate that the earthworms bio-accumulate or biodegrade “organochlorine pesticide” and “polycyclic aromatic hydrocarbons” (PAHs) residues in the medium in which it lives. References [75-78] found that the worm vermicasts sorbed higher amount of herbicides from the contaminated soil than the control soil due to the higher levels of organic carbon & more finer size of fractions in worm worked contaminated soils. Reference [79] found that due to earthworm burrowing actions, a greater degree of bound pesticides residues in soil was released as compared to those without worms. Earthworms restricted the formation of bound fraction of pesticides and also enhanced the release and mineralization of bound pesticides residues.

## 5) Studies on Removal of Polychlorinated Biphenyls (PCBs)

PCBs are a group of oily, colorless, organic fluids belonging to the same chemical family as the pesticide DDT. PCBs are categorized as unusually toxic and “persistent organic pollutant” (POPs). Reference [80] found that PCB contaminated soil treated with earthworms resulted in significantly greater PCB losses (average 52%) when compared to the soil without earthworm treatment which was 41%.

## 6.2. Our Studies on Vermiremediation Technology at Griffith University, Australia

Reference [81] studied the remedial action of earthworms on PAHs contaminated soils obtained from a former gas works site in Brisbane where gas was being produced from coal. The initial concentration of total PAHs compounds in the soil at site was greater than 11, 820 mg/kg of soil. The legislative requirements for PAHs concentration in soil in Australia

is only 100 mg/kg for industrial sites and 20 mg/kg for residential sites. Results showed that the earthworms could remove nearly 80% of the PAHs as compared to just 47% & 21% where it was not used and only microbial degradation occurred. This was just in 12 weeks study period. It could have removed by 100% in another few weeks. More significant was that the worm added soil became odor-free of chemicals in few days and were more soft and porous in texture.

### **6.3. Mechanism of Worm Action in Vermiremediation**

Earthworms uptake chemicals from the soil through passive “absorption” of the dissolved fraction through the moist “body wall” in the interstitial water and also by mouth and “intestinal uptake” while the soil passes through the gut. Earthworms apparently possess a number of mechanisms for uptake, immobilization and excretion of heavy metals and other chemicals. They either “bio-transform” or “biodegrade” the chemical contaminants rendering them harmless in their bodies. Some metals are bound by a protein called “metallothioneins” found in earthworms which has very high capacity to bind metals. The chloragogen cells in earthworms appears to mainly accumulate heavy metals absorbed by the gut and their immobilization in the small spheroidal chloragosomes and debris vesicles that the cells contain [70,76] found that earthworms biodegrade organic contaminants like phthalate, phenanthrene and fluoranthene.

### **6.4. Advantages of Vermiremediation Technology over the Mechanical & Chemical Treatment of Contaminated Sites**

The greatest advantage of the vermiremediation technology is that it is “on-site” treatment and there are no additional problems of “earth-cutting”, “excavation” and “transportation” of contaminated soils to the landfills or to the treatment sites incurring additional economic and environmental cost. Vermiremediation would cost about \$ 500-1000 per hectare of land as compared to \$ 10,000- 15,000 per hectare by mechanical excavation of contaminated soil & its landfill disposal.

Significantly, vermiremediation leads to total improvement in the quality of soil and land where the worms inhabit. Earthworms significantly contribute as soil conditioner to improve the physical, chemical as well as the biological properties of the soil and its nutritive value. They swallow large amount of soil everyday, grind them in their gizzard and digest them in their intestine with aid of enzymes. Only 5-10 percent of the digested and ingested material is absorbed into the body and the rest is excreted out in soil in the form of fine mucus coated granular aggregates called “vermicastings” which are rich in NKP (nitrates, phosphates and potash), micronutrients and beneficial soil microbes including the “nitrogen fixers” and “mycorrhizal fungus”.

Of considerable economic and environmental significance is that the worm feed used in vermiremediation process is necessarily an “organic waste” product. This means that it would also lead to reuse and recycling of vast amount of organic wastes which otherwise end up in landfills for disposal at high cost. And what is of still greater economic and environmental significance is that the polluted land is not only “cleaned-up” but also “improved in quality”. The soil becomes lighter and porous rich in biological activities and the productivity is increased to several times. During the vermi-remediation process of soil, the population of earthworms increases significantly benefiting the soil in several ways. A “wasteland” is transformed into “wonderland”. Earthworms are in fact regarded as “biological indicator” of good fertile soil and land.

### **6.5. Vermiremediation Technology Destined to Become a Global Movement**

Vermiremediation by commercial vermiculture in U.K. “Land Reclamation and Improvements Programs” has become an established technology for long-term soil decontamination, improvement & maintenance, without earth-cutting, soil excavation and use of chemicals”. U.S., Australia and other developed nations are also following [82,83].

## **7. Vermi-Agroproduction Technology for Sustainable Agriculture & Production of Safe Organic Food for Society**

Vermi-agroproduction technology promises to usher in the “Second Green Revolution” by completely replacing the destructive agro-chemicals which did more harm than good to both the farmers and their farmland during the “First Green Revolution” of the 1950-60’s. Studies indicate that vermicompost is a wonderful growth promoter and at least 4 times more nutritive than the conventional composts and gives 30-40% higher yield of crops over chemical fertilizers [84,85]. In Argentina, farmers consider it to be seven (7) times richer than conventional composts in nutrients and growth promoting values [52]. The “humic acid” in vermicompost (excreted by worms) stimulate plant growth even in small amount [86].

Earthworms restore & improve soil fertility and boost crop productivity by the use of their excreta (vermicast). They excrete beneficial soil microbes, and secrete polysaccharides, proteins and other nitrogenous compounds into the soil [87]. They promote soil fragmentation and aeration, and bring about “soil turning” and dispersion in farmlands. Worm activity can increase air-soil volume from 8-30%. One acre of land can contain up to 3 million earthworms the activities of which can bring up to 8-10 tons of “top soil” to the surface (in the form of vermicast) every year. Presence of worms improves water penetration in compacted soils by 50%. U.S. study indicates that 10,000 worms in a farm plot provides the same benefit as three farmers working 8 hours in shift all year round with 10 tons of manure applied in the plot [42]. Indian study showed that an earthworm population of 0.2-1.0 million per hectare of farmlands can be established within a short period of three months. On an average 12 tons/hectare/ year of soil or organic matter is ingested by earthworms, leading to upturning of 18 tons of soil/year, and the world over at this rate it may mean a 2 inches of fertile humus layer over the globe [48].

### **7.1. Some Important Studies on Vermi-Agroproduction Technology**

- 1) Reference [85] studied the agronomic impacts of vermicompost and found that it consistently improved seed germination, enhanced seedling growth and development, and increased plant productivity much more than would be possible from the mere conversion of mineral nutrients into plant-available forms. The growth responses of plants from vermicompost appears more like “hormone-induced activity” associated with the high levels of nutrients, humic acids and humates in vermicompost rather than boosted by high levels of plant-available nutrients.
- 2) Studies made by [88] at CSIRO Australia found that the earthworms can increase growth of wheat crops by 39%, grain yield by 35%, lift protein value of the grain by 12% & fight crop diseases. Reference [89] also studied that earthworms & its vermicast improve the growth and yield of wheat by more than 40%.
- 3) Reference [90] studied the agronomic impacts of vermicompost and inorganic (chemical) fertilizers on strawberries when applied separately and also in combination. The “yield” of marketable strawberries and the “weight” of the “largest fruit” was greater on plants in plots grown on vermicompost as compared to inorganic fertilizers. Also, farm soils applied with vermicompost had significantly greater “microbial biomass” than the one applied with inorganic fertilizers.
- 4) Reference [91] studied the agronomic impact of vermicompost on cherries and found that it increased yield of “cherries” for three (3) years after “single application” inferring that use of vermicompost in soil builds up fertility and restore its vitality for long time and its further use can be reduced to a minimum after some years of application in farms.
- 5) Reference [92] reported two-fold yield of grapes by vermicompost as compared to chemical fertilizers.

### **7.2. Our Studies on Vermi-Agroproduction Technology at Griffith University, Australia**

- 1) Reference [93] studied the growth impacts of earthworms and their vermicompost on potted corn crops and compared with chemical fertilizers. Vermicompost with earthworms in soil achieved excellent growth over chemical fertilizers. While the plants on chemicals grew only 5 cm in 7 weeks, those on vermicompost with worms grew 15 cm within the same period. Corn plants with worms & vermicompost also attained maturity (appearance of male & female reproductive organs) very fast. Another significant finding was that

plants on vermicompost demanded “less water” for irrigation.

2) Reference [93] also studied the growth impacts of earthworms with vermicompost on potted wheat plants and compared with chemical fertilizers & conventional compost (cow manure). Wheat crops on vermicompost with worms maintained very good growth from the very beginning & achieved maturity very fast. The striking rates of seed germination were very high, nearly 48 hours (2 days) ahead of others and the numbers of seed germinated were also high by nearly 20%. Plants were greener and healthier over others, with large numbers of tillers & long seed ears at maturity. Seeds were healthy and nearly 35-40% more as compared to plants on chemical fertilizers. What they achieved in just 5 weeks was achieved by others in 10 weeks. More significant was that the pot soil with vermicompost was very soft & porous and retained more moisture. Pot soil with chemical fertilizers was hard and demanded more water frequently.

3) Reference [93] also studied the growth impacts of vermicompost on farmed wheat crops and compared it with conventional cattle dung compost and chemical fertilizers. Exclusive application of vermicompost@25 quintal/ha boosted yield 18% higher over the chemical fertilizers (NPK: 120:40:60). On conventional compost applied @ 100 Q/ha (4 times more than vermicompost) the yield was 17% less than that on vermicompost. The requirement of irrigation was also reduced in vermicompost applied farm plots by 30-40%. Test results indicated better availability of essential micronutrients and useful microbes in vermicompost applied soils. Most remarkable was the significantly reduced (nearly 75%) incidences of “pest & disease attack” on vermicompost grown crops.

### **7.3. Vermiculture Technology can Reduce Soil Salinity & Improve Fertility of Sodic Soils**

Studies indicate that *Esinea fetida* can tolerate soils nearly half as salty as seawater i.e. 15 gm/kg of soil and also improve its biology and chemistry. (Average seawater salinity is around 35 g/L). Farmers at Phaltan in Satara district of Maharashtra, India, applied live earthworms to their sugarcane crop grown on saline soils irrigated by saline ground water. The yield was 125 tones/hectare of sugarcane and there was marked improvement in soil chemistry. Within a year there was 37% more nitrogen, 66% more phosphates and 10% more potash. The chloride content was less by 46% [93].

Reference [94] studied the production of potato (*Solanum tuberosum*) by application of vermicompost in a reclaimed sodic soil in India. With good potato growth the sodicity (ESP) of the soil was also reduced from initial 96.74 to 73.68 in just about 12 weeks. The average available nitrogen (N) content of the soil increased from initial 336.00 kg/ha to 829.33 kg/ha.

### **7.4. Advantages of Vermi-Agroproduction Technology**

#### **1) Can Replace Destructive & Costly Chemical Fertilizers from Farm Production**

Vermicompost has potential to replace the destructive chemical fertilizers from farm production. It can alone produce food over 30-40% higher than those produced by chemical fertilizers. It is at least 75% cheaper than the chemical fertilizers which are produced in factories from vanishing petroleum products generating huge waste & pollution.

#### **2) Produce Nutritive, Chemical-free Farm Products with Greater Storage Value**

The biggest advantage of great social significance is that the food produced is completely organic “safe & chemical-free”. Use of vermicompost enhances size, color, smell, taste, flavour and keeping quality (storage value) of flowers, fruits, vegetables and food grains.

### 3) Restore Natural Fertility of Farmland Soil

Upon successive years of application, vermicompost build-up the soils “natural fertility” improving its total physical (porous), chemical (rich in nutrients) and biological (beneficial soil microbes) properties. It also regenerates a rich population of worms in the farm soil from the cocoons which further help improve soil fertility and subsequently lesser amount of vermicompost is required to maintain a good yield and productivity. On the contrary, with the continued application of chemical fertilizers over the years the “natural fertility of soil is destroyed” and it becomes “addict”. Subsequently greater amount of chemicals are required to maintain the same yield & productivity of previous years.

### 4) Reduces Water for Farm Irrigation

Vermicompost has very “high porosity”, “aeration”, “drainage” and “water holding capacity” and thus its application in soil reduces the requirement of water for irrigation by 30-40%.

### 5) Kills Pests without Pesticides

Another big advantage of great social & environmental significance is that vermicompost “suppress plant disease” in crops and inhibit the soil-born fungal diseases. In field trials with pepper, tomatoes, strawberries and grapes significant suppression of plant-parasitic nematodes has been found. There is also significant decrease in arthropods (aphids, buds, mealy bug, spider mite) populations with 20% and 40% vermicompost additions [95]. Humus in vermicast extracts “toxins”, “harmful fungi & bacteria” from soil & protects plants. Actinomycetes in vermicast induces “biological resistance” in plants against pests & diseases. As such use of vermicompost significantly reduces the need for “chemical pesticides”. Our studies indicated over 75%.

## 7.5. The Global Movement for VAPT to Replace the Destructive Chemical Fertilizer

Worldwide farmers are desperate to get rid of the vicious circle of the use of chemical fertilizers as their cost have been constantly rising and also the amount of chemicals used per hectare has been steadily increasing over the years to maintain the yield & productivity of previous years. Nearly 3-4 times of agro-chemicals are now being used per hectare what was used in the 1960s. In Australia, the cost of MAP fertilizer has risen from AU \$ 530.00 to AU \$ 1500.00 per ton since 2006. So is the story everywhere in world because the chemical fertilizers are produced from “vanishing resources” of earth. Farmers urgently need a sustainable alternative which is both economical and also productive while also maintaining soil health & fertility. The new concept is “Ecological Agriculture” which is by definition different from “Organic Farming” that was focused mainly on production of chemical-free foods. Ecological agriculture emphasize on total protection of food, farm & human ecosystems while improving soil fertility & development of secondary source of income for the farmers. UN has also endorsed it. Vermiculture technology provides the best answer for ecological agriculture which is synonymous with “sustainable agriculture”.

## 8. The Vermi-Industrial Production Technology for Producing Raw Materials for Pharmaceutical & Consumer Industries

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### 1) Raw Materials for Rubber, Lubricant, Detergent, Soaps and Cosmetic Industries

Some biological compounds from earthworms are also finding industrial applications. Being “biodegradable” they are environmentally friendly and sustainable. Stearic acid found

in earthworms is a long chain saturated fatty acid and is widely used as “lubricant” and as an “additive” in industrial preparations. It is used in the manufacture of metallic stearates, pharmaceuticals soaps, cosmetics and food packaging. It is also used as a “softner”, “accelerator activator” and “dispersing agents” in rubbers. Industrial applications of lauric acid and its derivatives are as “alkyd resins”, “wetting agents”, a “rubber accelerator” and “softner” and in the manufacture of “detergents” and “insecticides” [54,96]. Worms are also finding new uses as a source of “collagen” for pharmaceutical industries.

## 2) Nutritive Feed Materials for Poultry, Dairy and Fishery Industries

Earthworms are rich in high quality protein (65%) and are “complete protein” with all essential amino acids. There is 70-80% high quality “lysine” and “methionine”. Glumatic acid, leucine, lysine & arginine are higher than in fish meals. Tryptophan is 4 times higher than in blood powder and 7 times higher than in cow liver. Worms are also rich in Vitamins A & B. There is 0.25 mg of Vitamin B<sub>1</sub> and 2.3 mg of Vitamin B<sub>2</sub> in each 100 gm of earthworms. Vitamin D accounts for 0.04-0.073% of earthworms wet weight. Thus worms are wonderful probiotic feed for fish, cattle and poultry industry. They are being used as “additives” to produce “pellet feeds” in the USA, Canada and Japan [42].

As earthworm protein is complete with 8-9 essential amino acids especially with the tasty “glutamic acid” it can be used for human beings as well. Worm protein is higher than in any meat products with about 2% lower fats than in meats and ideal for human consumption [51].

## 3) Bioactive Compounds for Pharmaceutical Industries to Produce Life Saving Medicines

A great news for the world vermitech scientists appeared in Philippines “News Today” on November 25, 2005 telling “Earthworms can help dissolve blood clots for stroke patients” [97]. In the last 10 years, a number of earthworm’s “clot-dissolving”, “lytic” and “immune boosting” compounds have been isolated and tested clinically [98,99]. Current researches made in Canada, China, Japan and other countries on the identification, isolation and synthesis of some “bioactive compounds” from earthworms (*Lumbricus rubellus* & *Eisenia fetida*) with potential medicinal values for treatment of heart diseases have brought revolution in the vermiculture studies [12,100,101]. Some of these compounds have been found to be enzymes exhibiting “anti-blood clotting” effects. Oral administration of earthworms powder & enzymes were found to be effective in treating “thrombotic diseases”, “arthritis”, “diabetes mellitus”, “pulmonary heart disease”, “lowering blood pressure”, “epilepsy”, “schizophrenia”, “mumps”, “exzema”, “chronic lumbago”, “anemia”, “vertigo” and “digestive ulcer” [44,102,103]. Scientist have also isolated “bronchial dilating” substance from earthworms.

Researchers at Quinghua University, China has extracted 4 valuable medicinal compounds from earthworms —a large molecular compound which has “anti-carcinogenic” effects [104]; medium molecular compound which has “anti-thrombosis” & “thrombus dissolution” effects [105]; a small molecular compounds which contain 17 kinds of amino acids, polymers, trace elements and vitamins; and a 4<sup>th</sup> product which can cure burns and scalds [42]. Reference [102] also extracted enzymes lumbritin, lumbrofebrin, terrestrolumbrolysin and “lumbrokinase” enzymes from *Lumbricus rubellus* useful in thrombolytic therapy.

The coelomic fluid of earthworms have been reported to have anti-pathogenic activities and are good biological compound for the production of “antibiotics” [34]. Several fatty acids have been isolated from earthworms. Important among them are “lauric acid” which are known for its “anti-microbial” properties. It is a precursor to “monolaurin” which is a more powerful “anti-microbial” agent that has potential to fight lipid-coated RNA and DNA viruses, several pathogenic Gram-positive bacteria, yeasts and various pathogenic protozoa [54]. Peptide “lumbricin I” isolated from *L. lumbricus* also exhibits antimicrobial activity against both Gram positive and Gram negative bacteria as well as fungi.

## 9. Conclusions & Remarks

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Vermiculture technologies for waste and land management and for improving soil fertility to promote crop productivity and production of valuable bioactive compounds of great

medicinal values has grown considerably in recent years all over the world and has been scientifically improved [106]. It is like getting “gold from garbage” (highly nutritive biofertilizer) by vermi-composting technology; “silver from sewage” (disinfected & detoxified water for reuse in agriculture & industries) by vermi-filtration technology; “converting a wasteland (chemically contaminated lands) into wonderland” (fertile land) by vermi-remediation technology; harvesting “green gold” (food crops) by using “black gold” (vermicompost) by agro-production technology; creating a “worm factory” to produce medicines & materials for societal use. The three versatile species *E. fetida*, *E. euginae* and *P. excavatus* performing wide social, economic & environmental functions occur almost everywhere.

The vermi-composting & vermi-agro-production technologies can together maintain the “global human sustainability cycle” & “circular economy”—using food wastes (negative economic & environmental value) of the society to produce food (positive socio-economic value) for the society again” while also protecting farm soil and improving its fertility (positive economic & environmental value). And if vermicompost can “replace” the “chemical fertilizers” for production of “safe organic foods” which has now been proved worldwide, it will be a giant step towards achieving global social, economic & environmental sustainability. With the growing global popularity of “organic foods” which became a US \$ 6.5 billion business every year by 2000, there will be great demand for vermicompost in future. US Department of Agriculture estimates 25% of Americans purchase organically grown foods at least once a week [42].

In all developed nations a “worm farm” has become a necessity in all wastewater & water treatment plants to resolve the problems of “sludge” which is a biohazard and needs safe disposal in secured landfills at high cost. Earthworms readily feed on them and convert into vermicompost.

In any vermiculture practice, “worm biomass” comes as a valuable by-product. It is finding uses and applications in modern medicine and in several industries for sustainable production of essential goods for societal use and consumption [107]. On commercial scale tons of worm biomass can result every year as under favorable conditions worms “double” their number at least every 60-70 days.

All infrastructure based on vermiculture technologies (vermicomposting, vermifiltration, vermiremediation & vermi-agroproduction) using earthworms are easy to construct, install and operate with minimum engineering considerations. They are highly economical and costeffective with highly valued by-products and end-products. It is basically a “one-time investment” technology as the earthworms multiply at a fast rate under favorable conditions of temperature and moisture and increase the pace and rapidity of the technological process.

Earthworms are truly justifying the beliefs and fulfilling the dreams of Sir Charles Darwin who called them as “unheralded soldiers’ of mankind” and “friends of farmers” and said that “there may not be any other creature in world that has played so important a role in the history of life on earth”. It is also justifying the beliefs of great Russian scientist Dr. Anatoly Igonin who said “Nobody and nothing can be compared with earthworms and their positive influence on the whole living Nature. They create soil & improve soil’s fertility and provides critical biosphere’s functions: disinfecting, neutralizing, protective and productive”. Future of mankind on earth beholds with the earthworms and our relationship must be maintained.

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