Project Chimera: Unified Master Asset List

**Core Vision:** Modern, High-Tech, Clinical/Scientific, Aspirational/Professional aesthetic; player-driven "Relaxed & Cozy" variations. Detail paramount for deep simulation, aiming for a granular, scientifically grounded foundation.

**I. Structural & Architectural Elements**

Purpose: Define grow spaces, support equipment, manage environment. Materials impact insulation, cleanliness, light/air sealing. Layout and zoning facilitate clean flow principles.

1. **Walls:** Sections/panels.
   * Types:
     + Interior Drywall
     + Interior Concrete
     + Insulated Panels (FRP, epoxy-coated, insulated metal panels)
       - Variants: Different R-values, material types affecting insulation, cleanliness, cost.
   * Properties: Cost, Appearance, Insulation (R-value), Light/Air barrier, Cleanliness. Coving at wall-floor junctions.
2. **Floors:** Sections.
   * Types:
     + Concrete (Sealed/Epoxy-Coated, Sloped to drain)
     + Wood (Residential)
     + Drains: Standard floor drains, Trench drains (varying capacity and material: plastic, stainless steel).
   * Properties: Cost, Appearance, Non-porous, Sloped to drain. Load ratings.
3. **Roofs/Ceilings:** Sections.
   * Types:
     + Drywall
     + Suspended Grid with Cleanable Tiles (Acoustic, Cleanroom types)
     + Open Rafters/Trusses (Wood, Metal)
     + Concrete
     + Greenhouse-specific roofing (polycarbonate, glass, retractable, diffused options).
   * Properties: Cost, Appearance, Insulation (R-value). Ceiling height considerations.
4. **Doors:** Various types.
   * Types:
     + Standard Interior Door
     + Basic Industrial Door
     + Industrial Roller Doors
     + Air Locks (single, double door systems)
     + Plastic Strip Curtains.
   * Properties: Cost, Appearance, Air Seal quality. Security keypads/access control levels.
5. **Windows:** Various types.
   * Types:
     + Standard Residential Window
     + Basic Industrial Window
     + Option to "Block Out" windows (basic blackout, insulated blackout material options).
     + Greenhouse-specific glazing (polycarbonate, diffused glass, double-paned).
   * Properties: Cost, Appearance, Light Transmission, Air Seal quality, Insulation value.
6. **Support Pillars/Beams:** Concrete, Steel. Part of map shells.
7. **Containment Structures (Grow Tents):** Pre-fab grow tents.
   * Types: Small, Medium, Large sizes.
   * Properties: Cost, Size, Light Reflection, Air Seal quality, Number of access points/vents.
8. **Stairs/Ladders/Catwalks:** For vertical access.
   * Types:
     + Basic Ladders
     + Stairs (various materials)
     + Catwalks (metal grating).

**II. Cultivation & Plant Care Tools**

Purpose: Plant maintenance, scouting, applying treatments. Tool quality/condition affects outcomes.

1. **Pruning & Cutting Tools:**
   * Types:
     + Snips/Scissors (Micro-Tip, Curved/Straight; Basic and Professional tiers)
     + Bypass Pruners (Standard, Heavy-Duty)
     + Scalpels (Basic, Sterile packs)
     + Loppers
     + Hand Saw
     + Large Hedge Trimmers (manual/electric).
   * Properties: Sharpness/Condition, Tool Durability/Cleanliness.
2. **Spraying & Application Tools:**
   * Types:
     + Hand Spray Bottles
     + Pump Sprayers (1-2 Gallon Backpack/Handheld)
     + Motorized spray carts
     + Foggers (ULV/Cold for disinfectants or pesticides)
     + Integrated Spraying Systems (boom sprayers).
   * Protective Gear for Spraying (Visual/Consumable): Tyvek-style suit, respirator mask, gloves.
3. **Scouting & Monitoring Tools:**
   * Types:
     + Sticky Traps (Yellow, Blue - Cards, Rolls)
     + Magnifying Loupe (Handheld, 10x, 30x, 60x with LED)
     + Microscopes (Handheld Digital/Standard - USB)
     + Benchtop Microscopes
     + Soil/Medium Sample Probes/Corers
     + Leaf Sample Bags/Vials
     + Simulated Chlorophyll Meter.
4. **Plant Support Tools:**
   * Types:
     + Trellis Netting (Plastic/Nylon, various square sizes, biodegradable)
     + Stakes (Bamboo/Plastic/Metal)
     + Tie Wire/Plant Ties (Soft ties, rolls).
5. **Cleaning Supplies for Tools & Facility:**
   * Types: Isopropyl Alcohol Wipes/Spray, Rags, Cleaning Solutions (Generic Disinfectant, Bleach Solution, Hydrogen Peroxide, Virkon S, Athena Reset).
6. **Clone Dunker Tool:**
   * Functionality: Custom tray attachment for inverting and submerging clone trays for IPM.
   * Material: 3D printed / plastic.
   * Use Case: Preventative IPM for clones.

**III. Nutrient & Irrigation Equipment**

Purpose: Store, mix, deliver water and nutrients.

1. **Manual Watering:**
   * Watering Cans (Various sizes)
   * Hoses with Nozzle/Wand (Different nozzle types: shower, jet).
2. **Reservoirs/Tanks:**
   * Types: Small (5-50 gallon), Medium (50-250 gallon), Large industrial batch tanks (1000-gallon+), stainless steel options, conical bottom tanks. Material options: Basic Plastic, Food-Grade Poly.
   * Properties: Capacity, Visual fill level. Cleanliness stat. Lid option.
3. **Pumps:**
   * Submersible Water Pumps (Various GPH ratings)
   * Inline Water Pumps (External to reservoir)
   * Air Pumps & Air Stones (For DWC, improves Dissolved Oxygen).
   * Properties: Flow Rate (GPH), Head Pressure, Power Consumption. Durability.
4. **Plumbing:**
   * Types:
     + Pipes (PVC/PEX visual, various diameters)
     + Fittings (Elbows, Tees, Couplings)
     + Valves (Manual Ball Valves, Gate Valves, Solenoid valves)
     + Drip Line & Emitters (Single point, multi-point drippers like Octo-bubblers, pressure compensating options)
     + Filters (Inline sediment filter, disc filters, screen filters, for water recycling)
     + Check valves
     + Pressure regulators
     + Flow meters.
   * Properties: Manual routing. Abstracted pressure loss. Potential for leaks.
5. **Nutrient Mixing:**
   * Buckets/Small Vats
   * Measuring Cups/Spoons/Basic Graduated Cylinders
   * Stirring Implement (Paddle/Rod - visual)
   * Large nutrient mixing stations, automated stirrers/agitators, transfer pumps.
6. **Growing Mediums/Substrates (Consumable):**
   * Types:
     + Bagged Potting Soil (Generic, Organic Mixes)
     + Coco Coir (Bricks/Bags, Loose fill, Pre-filled bags/pots). Buffered/Unbuffered.
     + Rockwool (Cubes, Blocks, Slabs). Wrapped/Unwrapped.
     + Perlite/Vermiculite (Bags)
     + Living Soil (Bagged, requires re-amending)
     + Peat Moss
     + Hydroton (clay pebbles)
     + Propagation Plugs (Root Riot, OrganiPlug, Jiffy Preforma, Grodan AOKs).
   * Properties: Water retention, aeration, pH buffering, EC holding capacity. Cost. Influence irrigation frequency and nutrient lockout risks.
7. **Nutrient Containers (Consumable):**
   * Types (Bottles/Bags representing):
     + Grow/Bloom Base Nutrients (A+B style or single part)
     + Cal-Mag Supplement
     + pH Up/Down Solutions
     + Rooting Hormones/Stimulants
     + Silicon Supplements
     + PK Booster
     + Flushing Agent / Late Flower Nutrient (Low N)
     + Basic Microbial Inoculant (mycorrhizae/bacteria)
     + Cleaning Agents for Irrigation Systems.
   * Properties: NPK values, type, concentration, mixing instructions.
8. **Automated Dosing/Fertigation Systems:**
   * Description: Links sensors (EC/pH) to injectors/pumps/valves for automated nutrient mixing and delivery. Stock tanks for A/B/C solutions, pH adjusters.
   * Examples: Netafim NetaFlex, Dosatron/Edatron injectors, Anderson Injectors, Priva systems.

**IV. Environmental Control Equipment**

Purpose: Manage temperature, humidity, CO2, airflow, light.

1. **HVAC Components:**
   * Window Air Conditioner
   * Portable Electric Heater
   * Small Dehumidifier (Collects water)
   * Small Humidifier (Requires water)
   * Large commercial HVAC units (rooftop/wall-mounted, split systems)
   * Advanced dehumidifiers
   * Commercial humidifiers
   * All-in-one HVACD units.
   * Properties: Radius/cone of influence, power consumption, heating/cooling/dehumidification/humidification rate. Noise level.
2. **Fans:**
   * Clip Fans (Adjustable direction)
   * Oscillating Standing/Wall Fans (Variable speeds)
   * Inline Duct Fan (Connects to ducting)
   * Large industrial HAF (Horizontal Air Flow) fans
   * V-Flow fans
   * Large drum fans
   * Exhaust fans with louvers.
   * Properties: Airflow (CFM), power consumption, noise level.
3. **Ducting:**
   * Flexible Ducting (Various diameters)
   * Rigid ducting (metal/plastic)
   * Large fabric air ducts/air socks
   * Insulated ducting options
   * Fittings (reducers, Y-splitters, elbows).
   * Properties: Visual, manual routing. Abstracted effect on airflow efficiency.
4. **CO2 Systems:**
   * CO2 Tank (Visual Asset - various sizes, refillable/replaceable)
   * Basic CO2 Regulator with Flow Meter (Manual release)
   * CO2 Tubing (Distribution)
   * CO2 Generators (propane/natural gas - produce heat/moisture)
   * Automated CO2 Controllers (linked to CO2 sensor)
   * Advanced delivery systems (distribution manifolds).
5. **Grow Lights:**
   * Types:
     + Fluorescent (T5/CFL, T5HO LED for clones)
     + Basic LED Panel (Fixed Spectrum, "blurple" or basic white full-spectrum, various wattages)
     + HID (MH/HPS with Ballast/Hood - bulb lifetime/degradation)
     + High-end LEDs (Adjustable spectrums, dimming, higher efficacy)
     + CMH/LEC
     + Under Canopy LED bars
     + Light Movers.
   * Properties: Wattage, Light Output (PPFD map/coverage), Heat Output, Power Consumption, Spectrum, Lifespan/Degradation.
6. **Light Timers/Controllers:**
   * Basic Mechanical/Digital Timer (On/off)
   * Advanced networked controllers (dimming, sunrise/sunset simulation, high-temp shutoff).
7. **Environmental Controllers:**
   * Basic Thermostat (Controls heater/AC)
   * Basic Humidistat (Controls humidifier/dehumidifier)
   * Basic CO2 Controller (Linked to CO2 sensor and regulator)
   * Advanced integrated controllers (managing multiple parameters, complex schedules, VPD targets, data logging).
8. **Sensors (Player Placed):**
   * Thermometer/Hygrometer (Digital Display, combined unit)
   * CO2 Monitor (Standalone)
   * Light Meter (Handheld PAR/PPFD meter)
   * Advanced networked environmental sensors (Temp, RH, CO2, PAR/PPFD)
   * Substrate sensors (VWC, EC, Temp)
   * Leaf Surface Temp Sensors
   * Inline Water Sensors (pH, EC, temp, DO)
   * Spore Traps
   * Weather stations (for greenhouses).
   * Properties: Accuracy, power (battery/wired), data output to dashboard. Placement affects reading.
9. **Air Filters:**
   * Small Carbon Filter with Inline Fan (Replaceable filter)
   * Intake filters (basic mesh/foam)
   * Large industrial carbon filters
   * HEPA filters (for clean rooms/intake)
   * Air Purification Systems (UV, PCO).
10. **Light Deprivation Systems:**
    * Description: Automated or manual tarps/covers (internal or external) for photoperiod control in greenhouses.
    * Examples: Blackout poly, automated curtain systems.

**V. Utility Systems & Equipment**

Purpose: Deliver power, water.

1. **Electrical:**
   * Power Sockets/Outlets (Visual, different types for load capacities)
   * Circuit Breaker Panel (Residential/Warehouse specific, interactive for resets, load balancing display)
   * Extension Cords/Power Strips (Visual, quality tiers)
   * Electrical Wiring (Visual, different gauges for manual routing).
2. **Water Supply:**
   * Water Tap/Connection Point (Abstracted)
   * RO Water Systems (Requires pre-filters, membrane, storage tank, produces wastewater)
   * Ozone Generators for water sanitation
   * Water chillers/heaters.
3. **Main Power Grid Connection Point (Abstracted):** Metered cost.
   * Generators (Diesel/Gas - require fuel, maintenance, produce noise/heat, auto-transfer switch)
   * Battery Banks/UPS (for critical systems)
   * Solar Panel Systems (Supplemental power)
   * Wind Turbines (Supplemental power)
   * CoGeneration (CoGen) systems.
4. **Water Treatment & Recirculation Systems:**
   * Description: Advanced filtration (sand, carbon, UV, ozone), treatment tanks, recirculation pumps. Monitoring of recirculated water quality.

**VI. Pots, Containers, & Growing Surfaces**

Purpose: Hold plants and growing medium.

1. **Pots & Containers:**
   * Types:
     + Standard Plastic Pots (Various sizes, color options, drainage holes)
     + Fabric Grow Bags (Various sizes, better aeration)
     + Seedling Trays/Flats (With or without individual cells, 50-cell, 72-cell)
     + Propagation Domes (Clear Plastic, fits on trays)
     + Air-Pruning Pots
     + Smart pots with integrated sensors
     + Biodegradable pots.
2. **Hydroponic Systems:**
   * Deep Water Culture (DWC) Buckets (Single plant, air stone, air pump, lid with net pot)
   * Rockwool Slabs/Cubes on Trays/Benches (Drain-to-waste or basic recirculating)
   * Ebb & Flow Tables (Flood and Drain Tables, tray, reservoir, pump, timer)
   * NFT (Nutrient Film Technique) channels
   * Aeroponics (Aeroponic cloners, True Aeroponic Systems with misters)
   * Vertical hydroponic towers
   * Aquaponics.
3. **Growing Benches/Tables:**
   * Basic Wire Racks/Shelving (Static)
   * Flood Tables (Plastic trays for Ebb & Flow or runoff capture)
   * Rolling Benches (Maximize space)
   * Multi-Tiered Vertical Racking (For veg/clone or vertical flower)
   * Dutch Trays/Bato Buckets.
4. **Specialized Hydroponic Components:**
   * Net Pots (Various sizes)
   * Aeroponic Spray Nozzles/Manifolds
   * Water Chillers/Heaters for reservoirs.

**VII. Pest & Disease Management**

Purpose: Monitor, identify, and treat plant health issues.

1. **Scouting Tools:** (Covered in Section II)
2. **Application Tools (Manual & Automated):** (Covered in Section II)
3. **Pesticides/Fungicides/Biologicals (Consumable):**
   * Types:
     + Neem Oil
     + Insecticidal Soap
     + Basic Fungicides (Copper Fungicide, Sulfur)
     + Sanitizers (Isopropyl Alcohol, Hydrogen Peroxide, specialized brands)
     + Beneficial Insects/Mites (Predatory Mites, Rove Beetles, Pirate Bugs, Ladybugs)
     + Biofungicides (Regalia, Rootshield)
     + Nematodes
     + Specific chemical pesticides/fungicides (varying toxicity/persistence).
   * Properties: Effect on specific pests/diseases, effectiveness variation.
4. **In-game "Plant Problems Guide" (UI/Asset):**
   * Content: Visual indicators, symptoms, solutions for common issues.
5. **Companion Planting:**
   * Examples: Marigolds, dill, basil, sunflowers. Abstracted pest deterrence.
6. **Pathogen Testing Kits (Simulated):**
   * Types: Basic HLVd test strips (less accurate), Sample collection kits for "lab" submission.
   * Functionality: Test plants for pathogens like HLVd. UI results after delay.

**VIII. Harvesting & Processing Equipment**

Purpose: Harvest, trim, dry, cure. Quality affected by process.

1. **Harvesting Tools:**
   * Large Trimming Shears/Pruners
   * HD Loppers
   * Hand Saw
   * Collection Totes/Bins (Plastic, Food-grade)
   * Tarps
   * Gloves (consumable or visual).
2. **Trimming Tools:**
   * Trim Scissors (Micro-Tip, spring-loaded). Multiple pairs.
   * Trim Bins/Trays (with kief screen).
   * Isopropyl Alcohol/Wipes & Rags (for cleaning tools).
   * Bowl Trimmers (Manual, Electric)
   * Automated Trimming Machines.
3. **Drying Equipment:**
   * Drying Racks (Mesh, stackable)
   * Clotheslines & Hangers (For whole plant hang drying)
   * Dedicated, environmentally controlled dry space (player-built).
4. **Curing Containers:**
   * Glass Jars (Various sizes, airtight lids)
   * Food-grade Buckets/Bins/Totes (Airtight lids)
   * Humidity Control Packs (Consumable for RH in cure)
   * Specialized Curing Bags (e.g., Grove Bags / TerpLoc visual equivalent).
5. **Weighing & Measuring:**
   * Digital Pocket Scale (Precision 0.01g)
   * Digital Bench Scale (Larger capacity, 0.1g or 1g accuracy)
   * Calibration Weights (Set)
   * Industrial Scales (Platform, Floor)
   * Multihead Weighers.
6. **Post-Harvest Processing Equipment (Full Suite):**
   * De-stemming/Bucking Machines
   * Bud Sorters
   * Automated Curing Systems (Climate-controlled rooms, smart containers)
   * Pre-Roll Machines (Cone fillers, automated rollers)
   * Automated Packaging Machinery (Baggers, weighers, labelers, wrappers)
   * Cold Storage (Refrigerators, freezers for fresh-frozen, -70C freezers)
   * Extraction/Concentrate Equipment:
     + Solventless: Rosin Presses (Hydraulic, Pneumatic), Ice Water Hash Systems (Washers, Bags, Freeze Dryers)
     + Solvent-Based: BHO/CO2/Ethanol Extraction Systems (Closed-loop extractors, pumps, recovery units)
     + Post-Extraction: Rotary Evaporators, Vacuum Ovens, Short Path Distillation Kits, Wiped Film Distillation Units, Chromatography Systems (Flash, Prep HPLC).
   * Edibles Kitchen Equipment: Industrial Mixers, Depositors, Molds, Coaters, Ovens.
   * Vape Cartridge Filling Machines.
   * Wood Chipper / Industrial Shredder (for waste).
7. **Transporting Equipment:**
   * Hand-drawn garden carts, Baskets, Plastic Totes
   * Small motorized transport (utility carts)
   * Portable conveyor belts
   * Baker's Racks.

**IX. Facility Furniture & Fixtures**

Purpose: Workspace, storage, safety, general utility, supporting cleanliness and professional aesthetics.

1. **Work Surfaces & Storage:**
   * Workbenches (Basic wood/metal, Stainless steel for labs/trim). Various sizes.
   * HD Shelving (Metal, Wire, Metro-style). Adjustable height.
   * Storage Cabinets (Basic Metal/Plastic, Lockable for chemicals/flammables).
   * Rolling Utility Carts (Plastic/Metal).
2. **Seating:**
   * Basic Stools, Folding Chairs, Ergonomic rolling chairs.
3. **Sinks & Cleaning:**
   * Industrial Sink/Wash Basin (Stainless Steel, single/double basin). Hot/cold water.
   * Faucet Fixtures (Standard, gooseneck).
   * Mop & Bucket, Broom & Dustpan.
   * Wet Floor Signs.
   * Hose Reels (wall mounted).
4. **Safety Equipment:**
   * Fire Extinguishers (ABC type, wall-mounted).
   * First Aid Kits (Wall-mounted visual).
   * Eye Wash Station
   * Emergency Shower
   * Spill Kits.
5. **General Utility & Sanitation:**
   * Wall Clocks.
   * Trash Cans/Waste Bins (Industrial rolling, various sizes, color-coded).
   * Recycling Bins.
   * Floor Mats/Anti-Fatigue Mats.
   * Lockers (for employees - visual).
   * Shoe Cover Dispensers & Shoe Covers (Consumable).
   * Foot Baths (Shallow tray with disinfectant solution).
   * Personnel Protective Equipment (PPE - visual/consumable): Lab coats/gowns, hairnets, beard nets, gloves (nitrile).
   * Dumpsters.
   * Advanced Sanitation Stations (hand wash, sanitizer dispenser units).
   * Air Shower (for clean room entry).

**X. Map Specific Assets**

Purpose: Define build environment, establish scale.

1. **Residential House Shell:** Pre-defined exterior/interior layout. Standard residential fixtures.
2. **Warehouse Shell:** Large, open-plan concrete structure. Industrial doors/windows. High ceilings. Loading dock.
3. **Greenhouse Structure:** Glass/Polycarbonate, Vents, Retractable Roofs/Shade Cloths, Dutch-style, Diffused Glass, Energy Curtains, Cooling Pad Walls, Fans.
4. **Research Lab Shell & Specialized Fixtures:** Cleanroom standards, dedicated TC labs, analytical labs, specialized benches.
5. **Outdoor Field Elements:** Landscape, Fencing, Raised Beds, Irrigation infrastructure.
6. **Vertical Farm Structure:** Multi-tiered Racking, integrated lighting/irrigation.
7. **Subterranean Lab Shell.**
8. **Abandoned Research Outpost Shell.**
9. **Geothermal Greenhouse Complex Shell.**

**XI. Decorative & "Cozy" Items**

Purpose: Player customization, "Cozy" aesthetic. Lore delivery.

1. Types:
   * Posters, Art Prints (Cannabis history, botanical illustrations, motivational, murals, branded art)
   * Rugs (various styles)
   * Small Decorative Furniture (end tables, chairs, bean bags)
   * Non-cannabis Houseplants, Orchids
   * Decorative Lighting (lamps, string lights, neon signs)
   * Personal Items (hats, dartboard, ping pong table, coffee maker, mini-fridge)
   * Paint/Texture options (walls/floors - selectable patterns/colors)
   * Branded Merchandise (T-shirts, hats - player's and NPCs')
   * Religious Iconography (generic symbols)
   * Whiteboards/Bulletin Boards (for player notes or decorative).

**XII. Plant Assets (Core for Procedural System)**

Purpose: Central visual output, dynamic GxE reflection.

1. **Base 3D Models:**
   * ~5-10 foundational landrace-inspired strains (visually distinct archetypes: "Narrow Leaf Drug Type," "Broad Leaf Drug Type," "Ruderalis Type," "Hemp Type").
   * Growth Stages: Seed (mottled, plain variations), Seedling (cotyledons, 1-3-5 leaflet progression), Vegetative (early, mid, late - increasing size/bushiness), Pre-Flower (calyx/pistil development), Flowering (early - small buds, mid - bud swell, late – dense buds, pistil color changes, trichome maturation: clear -> milky -> amber visual cues), Harvested Plant (cut stalk), Dried Buds (visual representation of quality/density).
   * Procedural Morphological Trait Variations (based on archetype, genetics, GxE):
     + Overall shape/height (Sativa-lanky vs. Indica-compact vs. Ruderalis-short)
     + Leaf shape (broad vs. narrow leaflets, leaflet count)
     + Bud structure (spear, round, foxtail; airy, dense, rock-hard)
     + Trichome density (low, medium, high "frost")
     + Pistil color change (white/cream -> orange/pink/red/brown)
     + Leaf angle/droop (hydration, genetics)
     + Color variations (anthocyanins - purples, reds; nutrient-deficiency colors)
     + Stem Structure (diameter, coloration, woody interior, hollow internodes)
     + Branching Pattern (internode length, apical dominance, lateral spread)
     + Leaf Morphology (serration, venation, phyllotaxy)
     + Leaf-to-Calyx Ratio
     + Root System (visualized in hydro/transparent pots - health, density, taproot vs. fibrous).
2. **Procedural Generation System (Software/Code Asset):**
   * Inputs: Genetic predispositions from parent strains (quantitative values for cannabinoid/terpene potentials, yield, flowering time, structural traits, stress tolerances, disease resistances), Environmental Data (light, temp, humidity, CO2, nutrients, water, substrate properties), Player Actions (training, defoliation, pruning, stress induction).
   * Outputs: Dynamic visual changes in all plant morphological traits, growth rates, health status, flowering progression, bud development, chemical profile outcomes.
3. **Dynamic Shader/Material Effects:**
   * Effects:
     + Nutrient deficiency/toxicity symptoms (chlorosis, necrosis, spotting, specific patterns for N, P, K, Ca, Mg, Fe, etc.)
     + Water stress (wilting, leaf crisping, turgidity changes)
     + Growth stage transitions (pistil development, bud swell, trichome opacity/color changes)
     + Pest/disease visuals (PM spots, mite webbing, thrip damage, fungal lesions, viral mottling/deformation)
     + Light stress (bleaching, burning, photoinhibition effects)
     + HLVd symptoms (stunting, dudding, abnormal branching, leaf curl/malformation, brittle stems, reduced trichomes)
     + Temperature stress (leaf discoloration, heat stress wilting, cold stress purpling).
4. **Performance Optimization:** LODs for all plant models/stages, instancing for dense grows.

**XIII. Data Collection & Lab Equipment**

Purpose: Environmental/plant sampling, analysis.

1. **Handheld Meters (Visual assets, tool-based interaction):**
   * pH meter (medium/water/runoff, requires calibration)
   * EC/PPM meter (TDS meter for medium/water/runoff, requires calibration)
   * Thermometer (air, water, medium - digital probe)
   * Hygrometer (air humidity - often combined with thermometer)
   * Soil Moisture Meter (probe type)
   * Simulated Chlorophyll Content meter
   * Handheld PAR/PPFD meter
   * Infrared Thermometer (leaf surface temp for VPD)
   * VPD Meter (calculates from temp/RH).
2. **Data Logging & Interface (Visual):**
   * Clipboard & Pen (Visual for manual note-taking UI)
   * Basic Digital Interface (on equipment or wall display for sensor readouts)
   * Laptop/Tablet/Desktop (UI access - dashboards, logs, ADA messages)
   * Whiteboard (Manual tracking/scheduling).
3. **Calibration Weights:** For calibrating scales.
4. **Advanced Lab Equipment:**
   * Benchtop Meters/Analyzers: Lab-grade EC/pH meter, Spectrophotometer, Moisture Analyzer.
   * Analytical Chemistry Equipment: HPLC, GC-MS, ICP, Elemental Analyzer, NIR/MIR Spectroscopy. Requires sample prep stations (fume hood, glassware, solvents, centrifuges, SPE manifolds).
   * Simulated Lab Analysis Interface (UI): Sample submission, results viewing (chromatograms, % values), comparison.
   * Water Activity Meters.
   * Sap Analysis Kits/Service (Simulated).
   * DNA/RNA Extraction Kits & PCR Machine (Thermocycler), Gel electrophoresis unit.
   * Microscopy Station (Advanced): High-power compound microscope with camera.

**XIV. UI & Data Visualization Elements**

Purpose: Present complex simulation data for decision-making. Modern, clean, dark mode, functional.

1. **Core Environmental Data Dashboards:** Real-time sensor readouts (Temp, RH, CO2, VPD, PAR/PPFD). Visual alerts.
2. **Plant Status UI Panels:** Health/growth info (stage, health status, warnings). Selected plant details.
3. **Logs/Notes Interface:** Player-written notes, auto-logging of critical alerts/actions.
4. **Alert System:** Tiered visual/audio cues (Blue/Info, Yellow/Warning, Red/Critical).
5. **Nutrient Management Interface:** Manual/automated mixing UI, application tracking, medium/runoff EC/pH/VWC monitoring.
6. **Genetics & Breeding Interface:** Parent selection, pollination confirmation, seed inventory, cloning UI. Trait display (potentials, ranges). Pedigree Charts, Punnett Squares, genetic marker info.
7. **Facility Construction & Management UI:** Grid-based placement, utility overlays.
   * Utility View ("X-Ray"): Highlighted power lines, water pipes, HVAC ducts.
8. **Economy UI:** NPC contracts, direct sales, operational cost tracking, P&L, CoP. POS System UI.
9. **Skill Tree UI ("The Tree"):** Visualized as Cannabis plant. Branches for cultivation, genetics, facility, harvest, science, business.
10. **ADA Communication UI:** Inbox, notifications, pop-ups.
11. **Tutorial/Info Overlays:** Contextual help.
12. **Graphs & Charts:** Historical trends for all logged data, multi-variable plots, heat maps.
13. **Brand Management / Contract Management UI:** Player brand creation, contract tracking, reputation.
14. **Augmented Reality Product Info System (Abstracted UI):** In-game detailed strain info/history viewer.

**XV. Advanced Breeding & Lab Equipment**

Purpose: Support high-tier breeding, genetic research, pathogen eradication.

1. **Tissue Culture Station & Components:** Sterile Work Area/Hood (Laminar Flow), Autoclave, Incubator, Dissecting Microscope, Racks for Culture Vessels, Culture Vessels (flasks, petri dishes, magenta boxes), pH meter, analytical balance, glassware, sterile tools (scalpels, forceps, spatulas), Bunsen burner/glass bead sterilizer, fridge/freezer.
   * Consumables: TC Media (MS, etc.), Agar, Plant Growth Regulators (Auxins, Cytokinins, Gibberellins), Sucrose, Antibiotics/Antifungals, Sterile Water, Disinfectants.
2. **Lab Furniture (Specialized):** Benches (Stainless/Chemical Resistant), Storage Cabinets (Chemical/Flammable), Lab Sinks with eyewash.
3. **Cryopreservation Unit:** Freezers (-80°C), LN₂ tanks, straws/vials.
4. **Advanced Genetic Modification Equipment (CRISPR-like System):** Electroporator/Gene Gun, Protoplast isolation setup.
5. **Bioinformatics Tools/Software (UI/Abstracted System):** Sequencing data analysis, GWAS, Genomic Selection, marker-assisted selection planning, DNA fingerprinting.
   * DNA Sequencer (Visual asset, abstracted function).

**XVI. Consumable Resources (Abstract/UI Representation)**

Purpose: Track/manage consumed resources.

1. **Water (Tap, RO, Treated):** Tracked in volume.
2. **Power (Grid, Generator Fuel, Battery Charge):** Tracked in kWh.
3. **Nutrients (All types):** Tracked by type and amount.
4. **CO2 (from Tanks/Generators):** Tracked by tank level/weight or fuel.
5. **Building Materials:** Generic "Building Supplies" resource.
6. **Seeds/Clones/TC Starts (Strain-specific):** Tracked by strain and quantity.
7. **Growing Medium (All types):** Tracked by bag/brick/slab count or volume.
8. **Finances (In-game Currency).**
9. **Pest/Disease Treatments (All types):** Tracked by container/application count.
10. **Cloning Gel/Solution.**
11. **Packaging Materials (All types):** Jars, bags, tubes, labels, etc.
12. **Specialized Lab Consumables (All types):** Media, PGRs, solvents, kits, etc.

**XVII. Finished Goods & Product Lines**

Purpose: Represent the marketable output of the facility.

1. **Flower (Bulk):** Ungraded/graded, unpackaged, cured flower.
2. **Packaged Flower (Eighths, Quarters, etc.):** Branded jars/Mylar bags. Quality tiers.
3. **Pre-Rolls (Nug Rolls, Infused Pre-rolls):** Ground flower/small nugs in cones, packaged.
4. **Vape Cartridges (Filled):** Extracted oil (distillate, live resin, rosin) in cartridges.
5. **Edibles (Gummies, Chocolates, Baked Goods, Tinctures, Beverages, Hash Drops):** Infused products.
6. **Concentrates (Solventless: Rosin, Ice Water Hash, Dry Sift; Solvent-Based: Shatter, Batter, Crumble, Sugar, Sauce, Diamonds, Live Resin, Distillate, THCa Isolate, RSO):** Various types.
7. **Moon Rocks:** Flower coated in oil and kief.
8. **Seeds (Player-Bred):** Packaged seeds (Regular, Feminized, Autoflower).
9. **Clones/Teens (Player-Selected):** Healthy, rooted cuttings/young plants.
10. **Hemp Products:** CBD flower, fiber, seeds for food (from hemp strains).
11. **THCA Flower:** Flower marketed under hemp regulations (low Delta-9 THC, high THCA).

**XVIII. Personnel / NPCs**

Purpose: Populate the world, offer services, contracts, lore.

* **Cultivation Roles:** Head Grower, Propagation Manager, Veg Technician, Flower Technician, IPM Specialist, Harvest Crew Leader, Trimmer, Cure Master.
* **Processing Roles:** Extraction Manager, Extraction Technician, Lab Analyst (QA/QC), Edibles Chef, Packaging Line Worker, Formulation Scientist.
* **Facility/Business Roles:** CEO/Owner (Player), Operations Manager, Facilities Manager, Compliance Officer, Marketing Manager, Sales Manager, Retail Manager, Budtenders.
* **Specialist NPCs/Vendors:** Genetic Breeders/Collectors, Equipment Suppliers, Nutrient Company Reps, Lab Testing Services, Energy Consultants, Packaging Suppliers, IPM Consultants, Crop Consultants, Business Consultants, Investors.