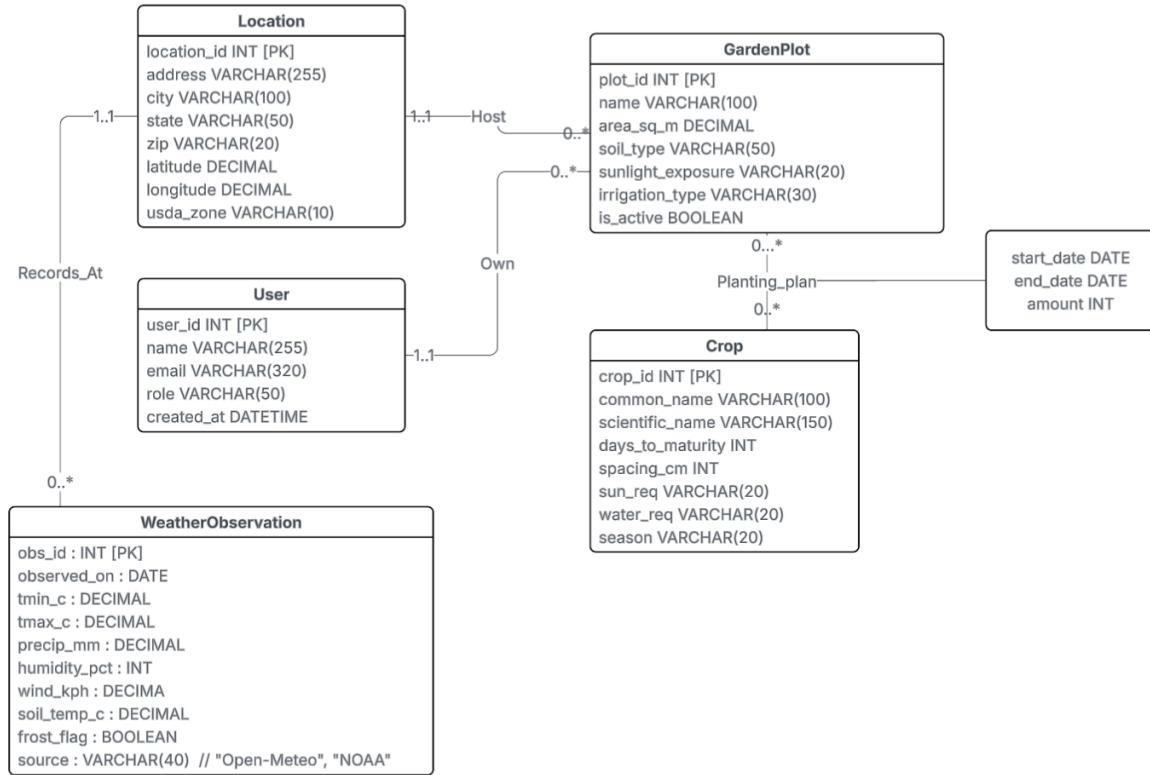


## Conceptual and Logical Database Design

### UML Diagram



### Entities: Assumptions and Explanations

User: One account manages gardens. We expect one owner per plot and possible future roles/permissions. Keep as an entity so one user can own many plots.

Location: A physical site (address, lat/long, USDA zone). Multiple plots can share one site and all weather attaches to the site. Keep as an entity to keep geo/zone data in one place.

GardenPlot: A distinct bed/area with stable traits (area, soil, sun, irrigation, active flag). It belongs to exactly one owner and one location.

Crop: Catalog of plant types with specific crop facts (days to maturity, spacing, sun/water needs). Kept as an entity so these facts are defined once and reused across many plantings.

WeatherObservation: Daily weather measured at a location (observed\_on date, tmin/tmax, precip, humidity, wind, optional soil temp, frost flag, source). Stored as its own entity for recommendations and trend analysis across time.

## **Relationships: Cardinality and Explanations**

User  $\leftarrow$  owns  $\rightarrow$  GardenPlot:

1  $\leftrightarrow$  many.

Each plot has exactly one accountable owner, while a user may own zero or many plots.

Location  $\leftarrow$  hosts  $\rightarrow$  GardenPlot:

1  $\leftrightarrow$  many.

A site can have many plots, each plot sits at exactly one site.

GardenPlot  $\leftarrow$  grows  $\rightarrow$  Crop (relationship with attributes – Planting):

many  $\leftrightarrow$  many, with relationship attributes

Location  $\leftarrow$  records\_at  $\rightarrow$  WeatherObservation:

1  $\leftrightarrow$  many.

Many daily observations over time per site. Each weather row belongs to one location.

## **Normalization / 3NF**

Location:

Left	Middle	Right
location_id	zip, latitude, longitude	address, city, state, usda_zone,

Garden Plot:

Left	Middle	Right
plot_id		name, area_sq_m, soil_type, sunlight_exposure, irrigation_type, is_active, owner_user_id, location_id

User:

Left	Middle	Right
user_id	email	name, role, created_at

Crop:

Left	Middle	Right
crop_id		common_name, scientific_name,

		days_to_maturity, spacing_cm, sun_req, water_req, season
--	--	----------------------------------------------------------------

Weather Observation:

Left	Middle	Right
obs_id		observed_on, tmin_c, tmax_c, precip_mm, humidity_pct, wind_kph, soil_temp_c, frost_flag, source, location_id

Functional Dependencies (FDs)

- $\text{location\_id} \rightarrow (\text{address}, \text{city}, \text{state}, \text{zip}, \text{latitude}, \text{longitude}, \text{usda\_zone})$
- $\text{plot\_id} \rightarrow (\text{name}, \text{area\_sq\_m}, \text{soil\_type}, \text{sunlight\_exposure}, \text{irrigation\_type}, \text{is\_active}, \text{owner\_user\_id}, \text{location\_id})$
- $\text{user\_id} \rightarrow (\text{name}, \text{email}, \text{role}, \text{created\_at})$
- $\text{crop\_id} \rightarrow (\text{common\_name}, \text{scientific\_name}, \text{days\_to\_maturity}, \text{spacing\_cm}, \text{sun\_req}, \text{water\_req}, \text{season})$
- $\text{obs\_id} \rightarrow (\text{observed\_on}, \text{tmin\_c}, \text{tmax\_c}, \text{precip\_mm}, \text{humidity\_pct}, \text{wind\_kph}, \text{soil\_temp\_c}, \text{frost\_flag}, \text{source}, \text{location\_id})$

Normalization check:

- Location:
  - $\text{location\_id} \rightarrow (\text{address}, \text{city}, \text{state}, \text{zip}, \text{latitude}, \text{longitude}, \text{usda\_zone})$
  - $\text{zip} \rightarrow (\text{city}, \text{state})$
  - $\text{latitude}, \text{longitude} \rightarrow (\text{usda\_zone})$
  - $\text{latitude}, \text{longitude} \rightarrow (\text{city}, \text{state})$
  - $\Rightarrow$  Location is not in 3NF because of transitive rule
    - Decompose into:
      - Location(location\_id [PK], address, zip, latitude, longitude)
      - PostalCode(zip [PK], city, state, usda\_zone)
- Garden Plot:
  - $\text{plot\_id} \rightarrow (\text{name}, \text{area\_sq\_m}, \text{soil\_type}, \text{sunlight\_exposure}, \text{irrigation\_type}, \text{is\_active}, \text{owner\_user\_id}, \text{location\_id})$
  - $\Rightarrow$  plot\_id is in 3NF
- User:
  - $\text{user\_id} \rightarrow (\text{name}, \text{email}, \text{role}, \text{created\_at})$
  - $\text{email} \rightarrow (\text{user\_id})$
  - $\Rightarrow$  user\_id is in 3NF by Trivial Rule (determines itself)
- Crop:
  - $\text{crop\_id} \rightarrow (\text{common\_name}, \text{scientific\_name}, \text{days\_to\_maturity}, \text{spacing\_cm}, \text{sun\_req}, \text{water\_req}, \text{season})$

- ⇒ crop\_id is in 3NF
- Weather Observation:
  - obs\_id → (observed\_on, tmin\_c, tmax\_c, precip\_mm, humidity\_pct, wind\_kph, soil\_temp\_c, frost\_flag, source, location\_id)
  - ⇒ obs\_id is in 3NF

Final 3NF:

- Location(location\_id [PK], address, zip, latitude, longitude)
- PostalCode(zip [PK], city, state, usda\_zone)
- GardenPlot(plot\_id [PK], name, area\_sq\_m, soil\_type, sunlight\_exposure, irrigation\_type, is\_active, owner\_user\_id [FK→User.user\_id], location\_id [FK→Location.location\_id])
- User(user\_id [PK], name, email UNIQUE, role, created\_at)
- Crop(crop\_id [PK], common\_name, scientific\_name, days\_to\_maturity, spacing\_cm, sun\_req, water\_req, season)
- WeatherObservation(obs\_id [PK], location\_id [FK→Location.location\_id], observed\_on DATE, tmin\_c, tmax\_c, precip\_mm, humidity\_pct, wind\_kph, soil\_temp\_c, frost\_flag, source)

## Relational Schema

Location(location\_id: INT [PK], address: VARCHAR(255), city: VARCHAR(100), state: VARCHAR(50), zip: VARCHAR(20), latitude: DECIMAL, longitude: DECIMAL, usda\_zone: VARCHAR(10))

User(user\_id: INT [PK], name: VARCHAR(255), email: VARCHAR(320), role: VARCHAR(50), created\_at: DATETIME)

GardenPlot(plot\_id: INT [PK], user\_id: INT [FK to User.user\_id], location\_id: INT [FK to Location.location\_id], name: VARCHAR(100), area\_sq\_m: DECIMAL, soil\_type: VARCHAR(50), sunlight\_exposure: VARCHAR(20), irrigation\_type: VARCHAR(30), is\_active: BOOLEAN)

Crop(crop\_id: INT [PK], common\_name: VARCHAR(100), scientific\_name: VARCHAR(150), days\_to\_maturity: INT, spacing\_cm: INT, sun\_req: VARCHAR(20), water\_req: VARCHAR(20), season: VARCHAR(20))

Planting\_Plan(plot\_id: INT [FK to GardenPlot.plot\_id], crop\_id: INT [FK to Crop.crop\_id], start\_date: DATE, end\_date: DATE, amount INT)

WeatherObservation(obs\_id: INT [PK], location\_id: INT [FK to Location.location\_id], observed\_on: DATE, tmin\_c: DECIMAL, tmax\_c: DECIMAL, precip\_mm: DECIMAL, humidity\_pct: INT, wind\_kph: DECIMAL, soil\_temp\_c: DECIMAL, frost\_flag: BOOLEAN, source: VARCHAR(40))