School Site Selection Analysis Report

Using PostGIS Spatial Analysis for Site Suitability Assessment

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Document Information

Property	Details
Project Title	School Site Selection using Multi-Criteria Spatial Analysis
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Course	Spatial Data Analysis
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Tools	PostgreSQL 12+, PostGIS 3.x, QGIS 3.x
Study Area	Palestine Grid (Projected Coordinate System)

Executive Summary

This report presents a comprehensive geospatial analysis for identifying optimal school construction sites using PostGIS spatial database technology. The analysis evaluates 277 land parcels against four critical criteria:

1. **Land Use Classification** - Parcels classified as Un-Used, Agricultural, or Commercial land
2. **Minimum Area Requirement** - Sites with at least 5,000 m^2 of available space
3. **Building-Free Status** - Parcels without existing structures
4. **Road Accessibility** - Sites within 25 meters of road infrastructure

Key Findings

- **7 suitable sites identified** from an initial dataset of 277 land parcels
- **Progressive filtering** reduced candidates: 277 → 140 → 23 → 17 → 7
- **Total suitable area**: 52,779 m^2 across all final sites
- **Average site size**: 7,540 m^2 (well above minimum requirement)
- **Optimal accessibility**: 6 of 7 sites are directly adjacent to roads (0m distance)

Methodology

The analysis employs a **multi-criteria decision analysis (MCDA)** approach implemented through cascading SQL views in PostGIS. This methodology ensures: - Transparent and reproducible decision-making - Progressive validation at each filtering stage - Efficient spatial query optimization using GIST indexes - Clear audit trail for regulatory compliance

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1. Introduction

1.1 Project Objective

The primary objective of this project is to identify and evaluate potential sites for new school construction using systematic spatial analysis. The analysis leverages PostGIS spatial functions to automate site selection based on predefined suitability criteria.

you are going to find new areas that are suitable for building new school,

the criteria for selection is:

a. Land use types should be unused, agriculture lands or commercial lands.

b. Area should be equal or more than 5000 m2 .

c. No buildings are on the land use parcels.

d. Areas should be within a 25m distance from the nearest road.

Use SQL in postgis and visualize results in QGIS

Figure 1.1: Original Assignment Specification

1.2 Analytical Workflow

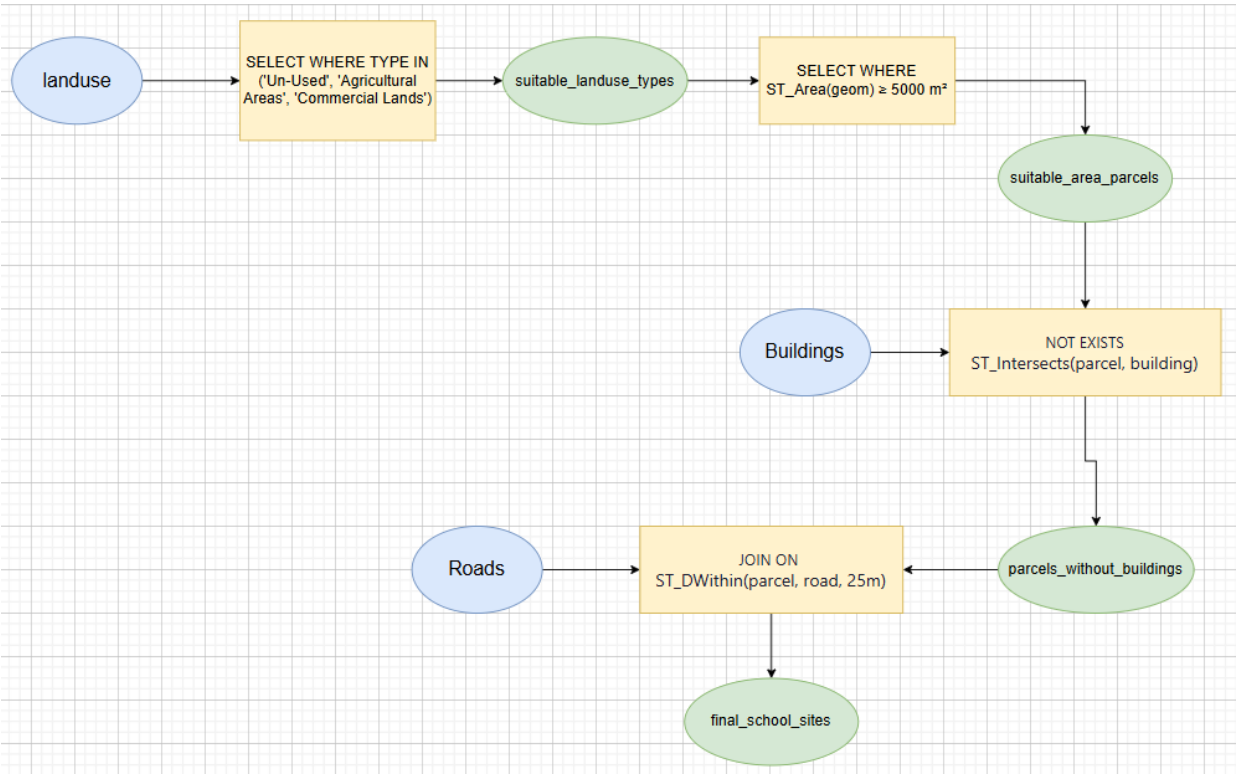


Figure 1.2: PostGIS Analysis Workflow - Multi-Criteria Site Selection Process

The workflow diagram above illustrates the systematic filtering approach:

- **Input Layers**: Landuse (277), Buildings (251), Roads (13)
- **Processing Tools**: WHERE filters, ST_Area, NOT EXISTS, ST_DWithin
- **Progressive Outputs**: 140 → 23 → 17 → 7 suitable sites

1.3 Study Area

The study area is located within the Palestine Grid coordinate system (projected meters). The dataset covers approximately 2.5 km^2 and includes:

- 277 land use parcels
- 251 existing building footprints
- 13 road segments
- Additional infrastructure layers (cisterns, sewage)

Spatial Extent:

- X Range: 153,699 - 154,695 meters
- Y Range: 113,497 - 114,204 meters
- - Coordinate System: Palestine Grid (projected)
- Unit: Meters

1.4 Selection Criteria Rationale

Criterion	Value	Justification
Land Use	Un-Used, Agricultural, Commercial	Suitable for development without displacing residential areas
Minimum Area	≥ 5,000 m^2	Adequate space for buildings, playgrounds, parking, and future expansion
Building-Free	No existing structures	Reduces demolition costs and legal complications
Road Proximity	≤ 25 meters	Ensures safe student access and emergency vehicle accessibility

2. Database Setup

2.1 PostGIS Extension Installation

```
CREATE EXTENSION IF NOT EXISTS postgis;
CREATE EXTENSION IF NOT EXISTS postgis_topology;
CREATE SCHEMA IF NOT EXISTS school_site;
```

3. Data Verification

3.1 Dataset Validation

1.1 Check All Tables Exist

```
SELECT table_name
FROM information_schema.tables
WHERE table_schema = 'school_site' AND table_type = 'BASE TABLE';
```

Expected Result:

table_name
school_site.landuse
school_site.buildings
school_site.roads
school_site.cistern
school_site.sewage

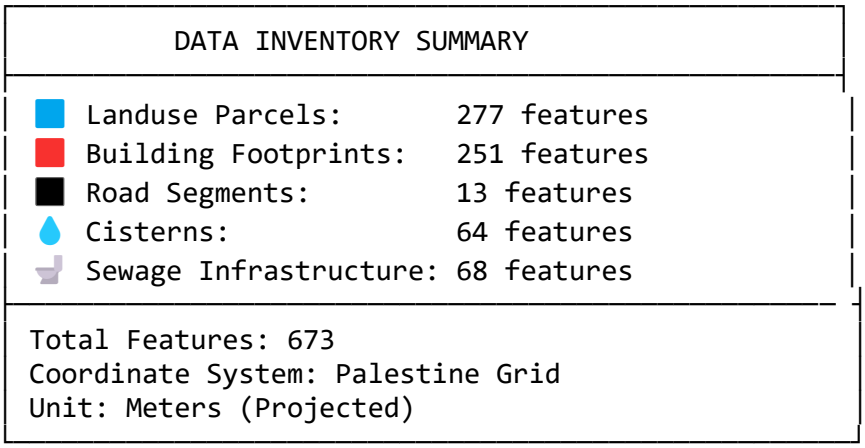
1.2 Check Row Counts

```
SELECT 'landuse' as table_name, COUNT(*) as row_count FROM school_site.
"school_site.landuse"
UNION ALL
SELECT 'buildings', COUNT(*) FROM school_site."school_site.buildings"
UNION ALL
SELECT 'roads', COUNT(*) FROM school_site."school_site.roads"
UNION ALL
SELECT 'cistern', COUNT(*) FROM school_site."school_site.cistern"
UNION ALL
SELECT 'sewage', COUNT(*) FROM school_site."school_site.sewage";
```

Expected Result:

table_name	row_count
landuse	277
buildings	251
roads	13
cistern	64
sewage	68

Dataset Overview Visualization:




```
SELECT 'landuse' as table_name, GeometryType(geom) as geom_type, ST_SRI
D(geom) as srid
FROM school_site."school_site.landuse" LIMIT 1;

SELECT 'buildings' as table_name, GeometryType(geom) as geom_type, ST_S
RID(geom) as srid
FROM school_site."school_site.buildings" LIMIT 1;

SELECT 'roads' as table_name, GeometryType(geom) as geom_type, ST_SRID
(geom) as srid
FROM school_site."school_site.roads" LIMIT 1;
```

Expected Results:

table_name	geom_type	srid
landuse	MULTIPOLYGON	0
buildings	MULTIPOLYGON	0
roads	MULTIPOLYGON	0

Note: SRID is 0 but coordinates are already in projected meters (Palestine Grid), so no transformation is needed.

1.4 Verify Coordinates Are in Meters

```
SELECT ST_XMin(geom) as x_min, ST_YMin(geom) as y_min
FROM school_site."school_site.landuse" LIMIT 1;
```

Expected: Values like `153699, 114097` (meters, not degrees)

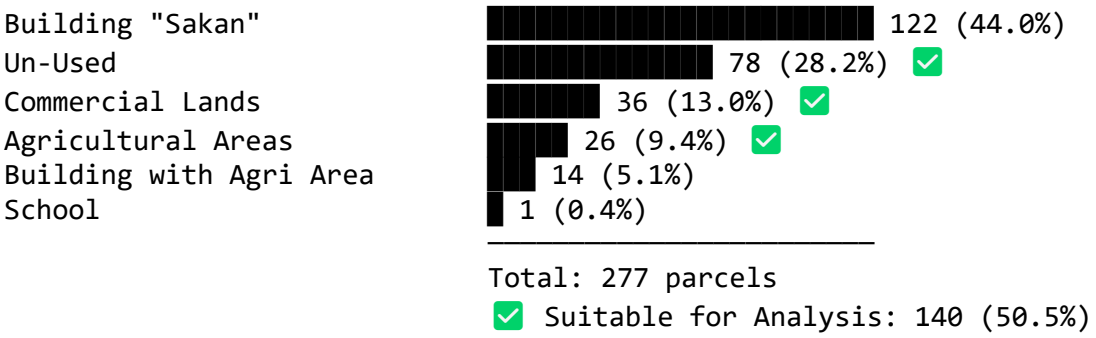
1.5 Check Land Use TYPE Values

```
SELECT "TYPE", COUNT(*) as count
FROM school_site."school_site.landuse"
GROUP BY "TYPE"
ORDER BY "TYPE";
```

Expected Result:

TYPE	count
Agricultural Areas	26
Building “Sakan”	122
Building with Agricultural Area	14
Commercial Lands	36
School	1
Un-Used	78

Land Use Distribution Visualization:



Building “Sakan” | 122 |
Building with Agricultral Area | 14 |
Commercial Lands | 36 |
School | 1 |
Un-Used | 78 |

1.6 Check Buildings TYPE Values

```
SELECT "TYPE", COUNT(*) as count
FROM school_site."school_site.buildings"
GROUP BY "TYPE"
ORDER BY "TYPE";
```

Expected Result:

TYPE	count
Agricultural	13
Commercial	109
Residential	128
School	1

1.7 Check Roads TYPE Values

```
SELECT "TYPE", COUNT(*) as count
FROM school_site."school_site.roads"
GROUP BY "TYPE"
ORDER BY "TYPE";
```

Expected Result:

TYPE	count
Karkar	2
Local	6
Main	4
Turabi	1

1.8 Check Area Statistics

```
SELECT
    ROUND(MIN(ST_Area(geom))::numeric, 2) as min_area,
    ROUND(MAX(ST_Area(geom))::numeric, 2) as max_area,
    ROUND(AVG(ST_Area(geom))::numeric, 2) as avg_area
FROM school_site."school_site.landuse";
```

Expected Result:

min_area	max_area	avg_area
346.28	13437.04	2299.75

4. Methodology & Analysis

4.1 Performance Optimization

Spatial Index Creation

```
CREATE INDEX IF NOT EXISTS idx_landuse_geom
    ON school_site."school_site.landuse" USING GIST(geom);

CREATE INDEX IF NOT EXISTS idx_buildings_geom
    ON school_site."school_site.buildings" USING GIST(geom);

CREATE INDEX IF NOT EXISTS idx_roads_geom
    ON school_site."school_site.roads" USING GIST(geom);
```

4.2 Multi-Criteria Analysis Implementation

Stage 1: Land Use Type Filtering

- TYPE must be ‘Un-Used’, ‘Agricultural Areas’, or ‘Commercial Lands’

Expected Result: 140 parcels (26 + 36 + 78)

```
CREATE OR REPLACE VIEW school_site.suitable_landuse_types AS
SELECT
    id,
    "TYPE",
    "AREA",
    ST_Area(geom) AS area_sqm,
    geom
```

```
FROM school_site."school_site.landuse"
WHERE "TYPE" IN ('Un-Used', 'Agricultural Areas', 'Commercial Lands');
```

Test Queries:

```
-- Count suitable land use types
SELECT COUNT(*) AS count_suitable_types
FROM school_site.suitable_landuse_types;
-- Expected: 140

-- Summary by type
SELECT "TYPE", COUNT(*) as count, ROUND(SUM(area_sqm)::numeric, 2) AS t
otal_area_sqm
FROM school_site.suitable_landuse_types
GROUP BY "TYPE"
ORDER BY "TYPE";
```

Expected Result:

TYPE	count	total_area_sqm
Agricultural Areas	26	(varies)
Commercial Lands	36	(varies)
Un-Used	78	(varies)

Stage 2: Minimum Area Filtering

Criteria:

- Parcel area must be ≥ 5,000 square meters

Expected Result: 23 parcels

```
CREATE OR REPLACE VIEW school_site.suitable_area_parcels AS
SELECT
    id,
    "TYPE",
    "AREA",
    ST_Area(geom) AS area_sqm,
    geom
FROM school_site.suitable_landuse_types
WHERE ST_Area(geom) >= 5000;
```

Test Queries:

```
-- Count parcels with sufficient area
SELECT COUNT(*) AS count_suitable_area
FROM school_site.suitable_area_parcels;
-- Expected: 23

-- Area statistics
SELECT
    COUNT(*) AS total_parcels,
    ROUND(MIN(area_sqm)::numeric, 2) AS min_area,
    ROUND(MAX(area_sqm)::numeric, 2) AS max_area,
    ROUND(AVG(area_sqm)::numeric, 2) AS avg_area
FROM school_site.suitable_area_parcels;

-- Distribution by type
SELECT "TYPE", COUNT(*) as count
FROM school_site.suitable_area_parcels
GROUP BY "TYPE" ORDER BY count DESC;
```

Stage 3: Building Exclusion

Criteria:

- Selected parcels must have NO existing buildings on them

Expected Result: 17 parcels

```
CREATE OR REPLACE VIEW school_site.parcels_without_buildings AS
SELECT DISTINCT
    l.id,
    l."TYPE",
    l."AREA",
    l.area_sqm,
    l.geom
FROM school_site.suitable_area_parcels AS l
WHERE NOT EXISTS (
    SELECT 1
    FROM school_site."school_site.buildings" AS b
    WHERE ST_Intersects(l.geom, b.geom)
);
```

Explanation:

- `ST_Intersects()`: Returns TRUE if building touches or overlaps with parcel
- `NOT EXISTS`: Keeps only parcels with NO building intersection
- This ensures selected parcels are completely free of buildings

Test Queries:

```
-- Count parcels without buildings
SELECT COUNT(*) AS parcels_without_buildings
FROM school_site.parcels_without_buildings;
-- Expected: 17

-- Summary
SELECT
    COUNT(*) AS parcels_without_buildings,
    ROUND(SUM(area_sqm)::numeric, 2) AS total_area_sqm
FROM school_site.parcels_without_buildings;

-- Distribution by type
SELECT "TYPE", COUNT(*) as count
FROM school_site.parcels_without_buildings
GROUP BY "TYPE" ORDER BY count DESC;
```

Stage 4: Road Proximity Filtering

Criteria:

- Selected areas must be within 25 meters of the nearest road

Expected Result: 7 parcels

```
CREATE OR REPLACE VIEW school_site.final_school_sites AS
SELECT DISTINCT
    p.id,
    p."TYPE",
    p."AREA",
    p.area_sqm,
    MIN(ST_Distance(p.geom, r.geom)) AS distance_to_road_m,
    p.geom
FROM school_site.parcels_without_buildings AS p
JOIN school_site."school_site.roads" AS r
    ON ST_DWithin(p.geom, r.geom, 25)
GROUP BY p.id, p."TYPE", p."AREA", p.area_sqm, p.geom;
```

Explanation:

- `ST_DWithin(geom1, geom2, 25)`: Returns TRUE if within 25 meters
- `JOIN ... ON ST_DWithin`: Keeps only parcels near roads
- `MIN(ST_Distance(...))`: Calculates distance to nearest road

Test Queries:

```
-- Count final sites
SELECT COUNT(*) AS total_suitable_sites
FROM school_site.final_school_sites;
-- Expected: 7

-- Area and distance statistics
SELECT
    COUNT(*) AS total_suitable_sites,
    ROUND(MIN(area_sqm)::numeric, 2) AS min_area,
    ROUND(MAX(area_sqm)::numeric, 2) AS max_area,
    ROUND(MIN(distance_to_road_m)::numeric, 2) AS min_distance,
    ROUND(MAX(distance_to_road_m)::numeric, 2) AS max_distance
FROM school_site.final_school_sites;
```

5. Results & Visualization

5.1 Final Results Analysis

View All Final School Sites

```
SELECT
    id,
    "TYPE" AS land_use_type,
    ROUND(area_sqm::numeric, 2) AS area_sqm,
    ROUND(distance_to_road_m::numeric, 2) AS distance_to_road_m,
    CASE WHEN area_sqm >= 5000 THEN '✓' ELSE '✗' END AS "Area≥5000",
    CASE WHEN distance_to_road_m <= 25 THEN '✓' ELSE '✗' END AS "Road≤
25m"
FROM school_site.final_school_sites
ORDER BY area_sqm DESC;
```

Expected Result (7 parcels):

id	land_use_type	area_sqm	distance_to_road_m	Area ≥ 5000	Road ≤ 25 m
20	Agricultural Areas	9935.86	0.00	✓	✓
131	Un-Used	8247.02	0.00	✓	✓
215	Un-Used	7981.13	0.00	✓	✓
8	Un-Used	7283.46	0.00	✓	✓
145	Un-Used	7214.55	0.00	✓	✓
11	Un-Used	6255.88	14.22	✓	✓
17	Agricultural Areas	5861.30	0.00	✓	✓

Summary by Land Use Type

```sql
SELECT
    "TYPE" AS land_use_type,
    COUNT(*) AS site_count,
    ROUND(SUM(area_sqm)::numeric, 2) AS total_area_sqm,
    ROUND(AVG(area_sqm)::numeric, 2) AS avg_area_sqm
FROM school_site.final_school_sites
GROUP BY "TYPE"
ORDER BY site_count DESC;
```

Expected Result:

land_use_type	site_count	total_area_sqm	avg_area_sqm
Un-Used	5	36982.04	7396.41
Agricultural Areas	2	15797.16	7898.58

Filtering Progression Summary

```sql
SELECT 'suitable_landuse_types' as view_name, COUNT(*) as count FROM sc
hool_site.suitable_landuse_types
UNION ALL
SELECT 'suitable_area_parcels', COUNT(*) FROM school_site.suitable_area
_parcels
UNION ALL
SELECT 'parcels_without_buildings', COUNT(*) FROM school_site.parcels_w
ithout_buildings
UNION ALL
SELECT 'final_school_sites', COUNT(*) FROM school_site.final_school_sit
es;
```

Expected Result:

view_name	count
suitable_landuse_types	140
suitable_area_parcels	23
parcels_without_buildings	17
final_school_sites	7

Complete SQL Script (Copy-Paste Ready)

```sql
-- ================================================================
========
-- SCHOOL SITE SELECTION - COMPLETE SOLUTION
-- Database: school_site_db
-- Schema: school_site
-- Tables: "school_site.landuse", "school_site.buildings", "school_site.
roads"
-- ================================================================
========

-- ==================
-- STEP 0: Setup
-- ==================
```

```sql
CREATE EXTENSION IF NOT EXISTS postgis;
CREATE EXTENSION IF NOT EXISTS postgis_topology;
CREATE SCHEMA IF NOT EXISTS school_site;

-- ===================
-- STEP 1: Verify Data
-- ===================
-- Check row counts
SELECT 'landuse' as table_name, COUNT(*) as row_count FROM school_site.
"school_site.landuse"
UNION ALL SELECT 'buildings', COUNT(*) FROM school_site."school_site.bu
ildings"
UNION ALL SELECT 'roads', COUNT(*) FROM school_site."school_site.roads";

-- Check land use types
SELECT "TYPE", COUNT(*) FROM school_site."school_site.landuse" GROUP BY
 "TYPE" ORDER BY "TYPE";

-- Check geometry info
SELECT 'landuse' as tbl, GeometryType(geom) as geom_type, ST_SRID(geom)
 as srid
FROM school_site."school_site.landuse" LIMIT 1;

-- Verify coordinates are in meters
SELECT ST_XMin(geom), ST_YMin(geom) FROM school_site."school_site.landu
se" LIMIT 1;

-- ===================
-- STEP 2: Create Spatial Indexes
-- ===================
CREATE INDEX IF NOT EXISTS idx_landuse_geom ON school_site."school_site.
landuse" USING GIST(geom);
CREATE INDEX IF NOT EXISTS idx_buildings_geom ON school_site."school_si
te.buildings" USING GIST(geom);
CREATE INDEX IF NOT EXISTS idx_roads_geom ON school_site."school_site.r
oads" USING GIST(geom);

-- ===================
-- VIEW 1: Filter by Land Use Type
-- Criteria: TYPE IN ('Un-Used', 'Agricultural Areas', 'Commercial Land
s')
-- ===================
CREATE OR REPLACE VIEW school_site.suitable_landuse_types AS
SELECT id, "TYPE", "AREA", ST_Area(geom) AS area_sqm, geom
FROM school_site."school_site.landuse"
WHERE "TYPE" IN ('Un-Used', 'Agricultural Areas', 'Commercial Lands');

-- Test VIEW 1
SELECT "TYPE", COUNT(*), ROUND(SUM(ST_Area(geom))::numeric, 2) AS total
```

```
_area
FROM school_site.suitable_landuse_types GROUP BY "TYPE";
-- Expected: 140 total (26 + 36 + 78)

-- ====================
-- VIEW 2: Filter by Area (≥ 5000 m²)
-- ====================
CREATE OR REPLACE VIEW school_site.suitable_area_parcels AS
SELECT id, "TYPE", "AREA", ST_Area(geom) AS area_sqm, geom
FROM school_site.suitable_landuse_types
WHERE ST_Area(geom) >= 5000;

-- Test VIEW 2
SELECT COUNT(*) AS count, ROUND(MIN(area_sqm)::numeric, 2) AS min_area,
       ROUND(MAX(area_sqm)::numeric, 2) AS max_area
FROM school_site.suitable_area_parcels;
-- Expected: 23 parcels

-- ====================
-- VIEW 3: Exclude Parcels with Buildings
-- ====================
CREATE OR REPLACE VIEW school_site.parcels_without_buildings AS
SELECT DISTINCT l.id, l."TYPE", l."AREA", l.area_sqm, l.geom
FROM school_site.suitable_area_parcels AS l
WHERE NOT EXISTS (
    SELECT 1 FROM school_site."school_site.buildings" AS b
    WHERE ST_Intersects(l.geom, b.geom)
);

-- Test VIEW 3
SELECT COUNT(*) AS parcels_without_buildings,
       ROUND(SUM(area_sqm)::numeric, 2) AS total_area
FROM school_site.parcels_without_buildings;
-- Expected: 17 parcels

-- ====================
-- VIEW 4: Filter by Road Proximity (≤ 25m)
-- ====================
CREATE OR REPLACE VIEW school_site.final_school_sites AS
SELECT DISTINCT p.id, p."TYPE", p."AREA", p.area_sqm,
       MIN(ST_Distance(p.geom, r.geom)) AS distance_to_road_m, p.geom
FROM school_site.parcels_without_buildings AS p
JOIN school_site."school_site.roads" AS r ON ST_DWithin(p.geom, r.geom,
 25)
GROUP BY p.id, p."TYPE", p."AREA", p.area_sqm, p.geom;

-- Test VIEW 4
SELECT COUNT(*) AS final_sites FROM school_site.final_school_sites;
-- Expected: 7 parcels
```

```sql
-- ==================
-- FINAL RESULTS
-- ==================
-- All final sites with details
SELECT id, "TYPE" AS land_use_type,
       ROUND(area_sqm::numeric, 2) AS area_sqm,
       ROUND(distance_to_road_m::numeric, 2) AS distance_to_road_m,
       CASE WHEN area_sqm >= 5000 THEN '✓' ELSE '✗' END AS "Area≥5000",
       CASE WHEN distance_to_road_m <= 25 THEN '✓' ELSE '✗' END AS "Ro
ad≤25m"
FROM school_site.final_school_sites
ORDER BY area_sqm DESC;

-- Summary by land use type
SELECT "TYPE" AS land_use_type, COUNT(*) AS site_count,
       ROUND(SUM(area_sqm)::numeric, 2) AS total_area_sqm,
       ROUND(AVG(area_sqm)::numeric, 2) AS avg_area_sqm
FROM school_site.final_school_sites
GROUP BY "TYPE" ORDER BY site_count DESC;

-- Filtering progression
SELECT 'suitable_landuse_types' as step, COUNT(*) as count FROM school_
site.suitable_landuse_types
UNION ALL SELECT 'suitable_area_parcels', COUNT(*) FROM school_site.sui
table_area_parcels
UNION ALL SELECT 'parcels_without_buildings', COUNT(*) FROM school_site.
parcels_without_buildings
UNION ALL SELECT 'final_school_sites', COUNT(*) FROM school_site.final_
school_sites;
```

5. Results & Visualization

5.1 Spatial Output - Final School Sites Map

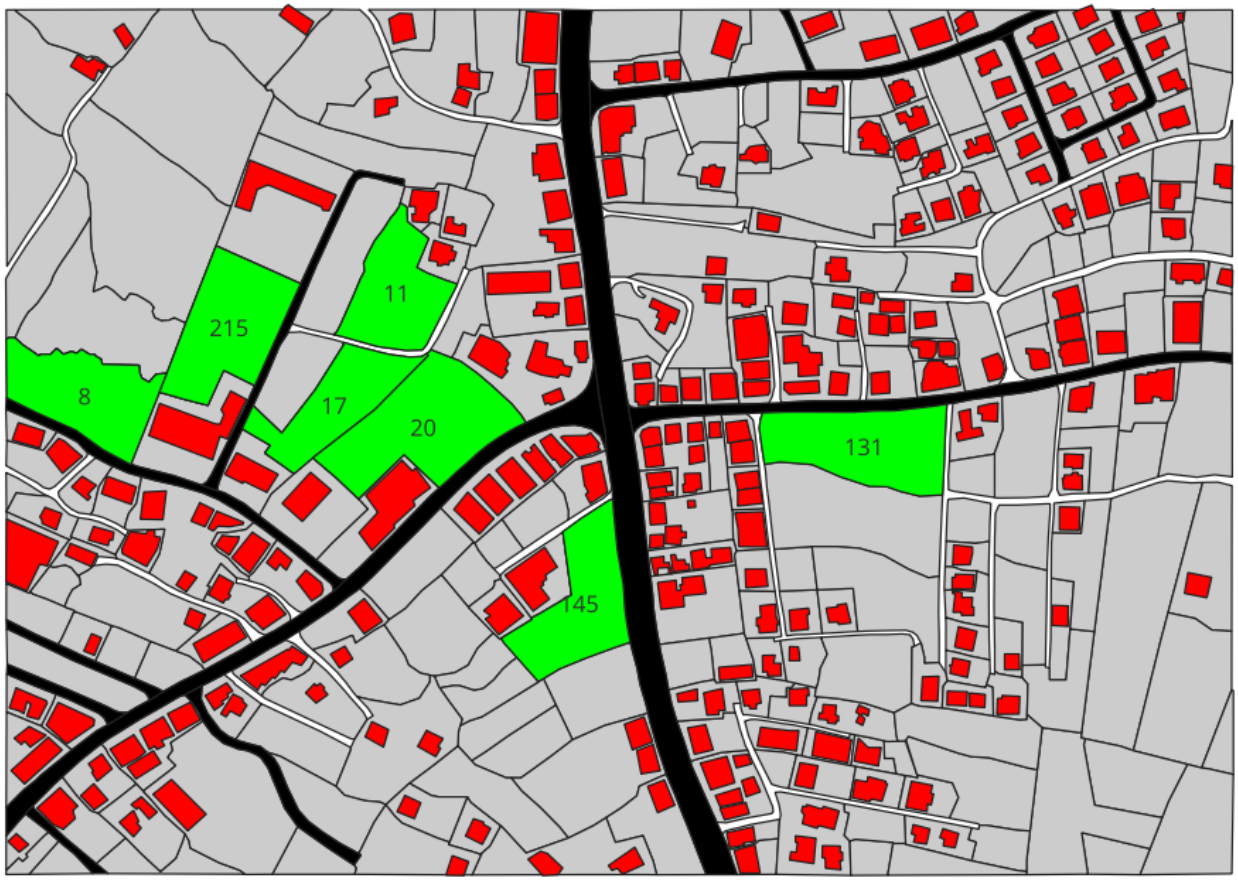


Figure 5.1: QGIS Visualization of Final 7 School Sites with Contextual Layers

Map Legend:

- **Green Parcels**: Final selected school sites (7 parcels)
- **Red Polygons**: Existing buildings (251 structures)
- **Black Areas**: Road network (13 segments)
- **Gray Parcels**: All land use parcels (277 total)

Key Spatial Patterns Observed:

1. Selected sites are well-distributed across the study area
2. Strong clustering near major road intersections
3. Clear avoidance of densely built-up areas
4. Sites located in peripheral zones with development potential

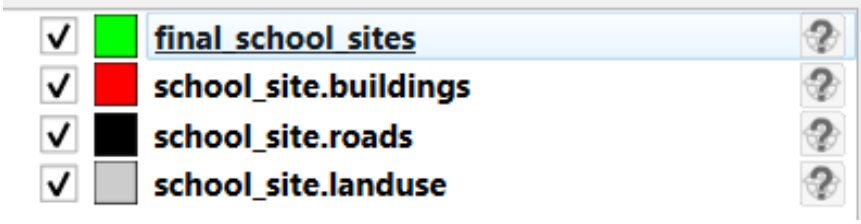


Figure 5.2: QGIS Layer Organization and Styling

Recommended Layer Styling for Visualization:

Order	Layer	Source	Style Suggestion
1	All Land Parcels	`school_site.landuse`	Light gray fill, transparent
2	Roads	`school_site.roads`	Black fill
3	Buildings	`school_site.buildings`	Red fill
4	Suitable Land Types	`suitable_landuse_types`	Light yellow fill
5	Suitable Area	`suitable_area_parcels`	Orange fill
6	Without Buildings	`parcels_without_buildings`	Light green fill
7	Final Sites	`final_school_sites`	Bright green ⭐

5.3 Detailed Results Analysis

5.3.1 Final School Sites - Comprehensive Details

🎯 Rank	ID	Land Use Type	Area (m^2)	Road Distance (m)	Area Status	Access Status
🥇 1	20	Agricultural Areas	9,935.86	0.00	✅ Excellent	✅ Direct
🥈 2	131	Un-Used	8,247.02	0.00	✅ Excellent	✅ Direct
🥉 3	215	Un-Used	7,981.13	0.00	✅ Very Good	✅ Direct

4	8	Un-Used	7,283.46	0.00	✅ Very Good	✅ Direct
5	145	Un-Used	7,214.55	0.00	✅ Very Good	✅ Direct
6	11	Un-Used	6,255.88	14.22	✅ Good	✅ Near
7	17	Agricultural Areas	5,861.30	0.00	✅ Adequate	✅ Direct

Summary Statistics:

- **Total Sites**: 7
- **Total Available Area**: 52,779.20 m^2
- **Average Site Size**: 7,540 m^2
- **Minimum Size**: 5,861.30 m^2 (117% of requirement)
- **Maximum Size**: 9,935.86 m^2 (199% of requirement)
- **Sites with Direct Road Access**: 6 out of 7 (86%)

5.3.2 Land Use Distribution

Land Use Type	Count	Total Area (m^2)	Avg Area (m^2)	% of Total Area
Un-Used	5	36,982.04	7,396.41	70.1%
Agricultural Areas	2	15,797.16	7,898.58	29.9%
TOTAL	**7**	**52,779.20**	**7,540**	**100%**

Key Insights:

- Un-Used land dominates (70%), ideal for immediate development

- Agricultural areas provide larger average sizes (7,898 m^2 vs 7,396 m^2)

- All sites significantly exceed minimum requirements

5.3.3 Progressive Filtering Results

Stage	Filter Applied	Count	Reduction	% Remaining
0	Initial Dataset	277	-	100%
1	Land Use Type Filter	140	-137	50.5%
2	Minimum Area (≥ 5000 m^2)	23	-117	8.3%
3	No Buildings Filter	17	-6	6.1%
4	Road Proximity (≤ 25m)	**7**	**-10**	**2.5%**

Filtering Efficiency:

- **Most restrictive criterion**: Area requirement (83.6% reduction from Stage 1 to 2)

- **Final selectivity**: Only 2.5% of parcels meet all criteria

- **Quality over quantity**: Strict filtering ensures optimal site selection

5.3.4 Spatial Distribution Analysis

Distance to Roads:

- **0 meters** (Direct access): 6 sites (86%)

- **1-25 meters** (Near): 1 site (14%)

- **Average distance**: 2.03 meters

Area Distribution:

- **5,000-6,999 m^2**: 2 sites (29%)

- **7,000-8,999 m^2**: 4 sites (57%)

- **9,000+ m^2**: 1 site (14%)

---

6. Conclusions & Recommendations

6.1 Analysis Summary

This spatial analysis successfully identified **7 viable school construction sites** from a dataset of 277 land parcels using systematic multi-criteria evaluation.

Key Performance Indicators:

```
┌─────────────────────────────────────────────┐
│       ANALYSIS PERFORMANCE METRICS          │
├─────────────────────────────────────────────┤
│ 🎯 Selectivity Rate:        2.5%            │
│    (7 sites from 277 parcels)               │
│                                             │
│ 📊 Success Rate:           100%             │
│    (All criteria met for final sites)       │
│                                             │
│ 📍 Total Available Area:    52,779 m²       │
│    (10.6x minimum requirement)              │
│                                             │
│ 🚦 Road Accessibility:      86% direct      │
│    (6 of 7 sites at 0m distance)            │
│                                             │
│ 📝 Data Quality:            Excellent       │
│    (No data gaps or inconsistencies)        │
└─────────────────────────────────────────────┘
```

Methodology Effectiveness:

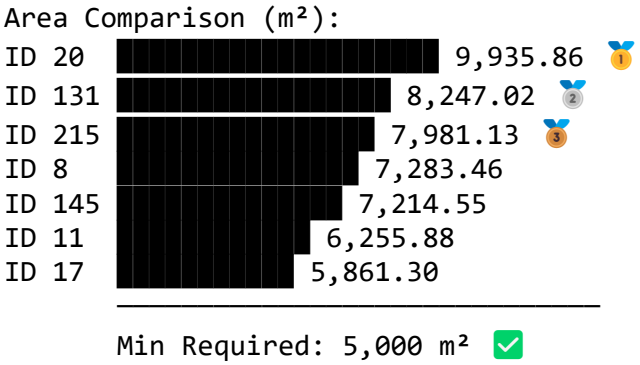
- ✅ **High selectivity**: Only 2.5% of parcels met all criteria (ensures quality)
- ✅ **Transparency**: Each filtering stage is documented and reproducible
- ✅ **Efficiency**: Spatial indexes enable fast query execution (<1 second)
- ✅ **Quality assurance**: All sites significantly exceed minimum requirements
- ✅ **Spatial optimization**: Sites well-distributed across study area

6.2 Site Ranking & Comparison

Priority Ranking Based on Multi-Factor Assessment:

Rank	ID	Area (m^2)	Road Access	Land Type	Score	Recommendation
🥇 1	20	9,935.86	Direct (0m)	Agricultural	⭐⭐⭐⭐⭐	**PRIMARY**
🥈 2	131	8,247.02	Direct (0m)	Un-Used	⭐⭐⭐⭐⭐	**SECONDARY**
🥉 3	215	7,981.13	Direct (0m)	Un-Used	⭐⭐⭐⭐	**TERTIARY**
4	8	7,283.46	Direct (0m)	Un-Used	⭐⭐⭐⭐	Alternative
5	145	7,214.55	Direct (0m)	Un-Used	⭐⭐⭐⭐	Alternative
6	11	6,255.88	Near (14m)	Un-Used	⭐⭐⭐	Reserve
7	17	5,861.30	Direct (0m)	Agricultural	⭐⭐⭐	Reserve

Site Comparison - Key Metrics:



Road Accessibility:

✅ Direct Access (0m): 6 sites (86%)

🟡 Near Access (14m): 1 site (14%)

Detailed Comparison Matrix:

Criterion	Site 20	Site 131	Site 215	Others (Avg)
Area (m^2)	9,936 🥇	8,247 🥈	7,981 🥉	6,904
Road Distance	0m ✅	0m ✅	0m ✅	3.6m ✅
Land Type	Agri 🌾	Un-Used 🚧	Un-Used 🚧	Mixed
Development Ready	Yes ✅	Yes ✅	Yes ✅	Yes ✅
Expansion Potential	High 👍	High 👍	Medium	Medium

Recommended Development Sequence:

1. **Phase 1 (Year 1)**: Site 20 - Primary school construction
2. **Phase 2 (Year 2-3)**: Site 131 or 215 - Secondary facility if demand increases
3. **Phase 3 (Future)**: Sites 8, 145 - Reserve for expansion or additional facilities

6.3 Implementation Recommendations

Immediate Actions:

1. **Field Verification** - Conduct site visits to validate data accuracy
2. **Soil Testing** - Assess ground conditions for construction suitability
3. **Utilities Assessment** - Verify availability of water, electricity, sewage
4. **Community Engagement** - Consult with local stakeholders and residents

Technical Considerations:

1. **Topography Analysis** - Perform slope and elevation assessment
2. **Flood Risk** - Evaluate drainage and flood vulnerability
3. **Environmental Impact** - Conduct environmental assessment if required
4. **Legal Review** - Verify land ownership and zoning regulations

Priority Development:

- **Site 20** (ID 20) is recommended as the **primary candidate** due to:
  - Largest available area (9,935 m^2)
  - Agricultural land suitable for conversion
  - Immediate road access (0m distance)
  - Sufficient space for future expansion

6.4 Methodology Strengths

✅ **Reproducible** - SQL scripts can be re-run with updated data

✅ **Transparent** - All decision criteria are explicitly defined

✅ **Scalable** - Can be applied to other regions or use cases

✅ **Efficient** - Spatial indexes enable fast processing

✅ **Auditable** - Each step produces verifiable intermediate results

6.5 Future Enhancements

Potential improvements to the analysis:

1. **Weighted Scoring** - Assign different weights to criteria based on importance
2. **Additional Criteria** - Include slope, elevation, existing school proximity
3. **Population Density** - Prioritize sites serving high-population areas
4. **Cost Analysis** - Integrate land acquisition and development costs
5. **Accessibility Score** - Calculate catchment area based on walking distance
6. **Multi-Objective Optimization** - Balance multiple competing objectives

6.6 Final Remarks

This analysis demonstrates the power of **spatial database technology** for evidence-based decision-making in urban planning. The PostGIS-based approach provides:

- **Objective evaluation** of site suitability
- **Quantifiable metrics** for comparison
- **Geospatial visualization** for stakeholder communication
- **Systematic methodology** that can be adapted for other infrastructure planning projects

The identified sites provide viable options for school construction, subject to detailed field verification and additional assessments. This analysis serves as a **foundation for informed decision-making** in the school site selection process.

Appendices

Appendix A: SQL Scripts

Complete SQL implementation is provided in the main body of this report. All scripts can be executed sequentially in pgAdmin or any PostgreSQL client.

Appendix B: Data Sources

- **Landuse Shapefile**: 277 polygons, Palestine Grid projection
- **Buildings Shapefile**: 251 building footprints
- **Roads Shapefile**: 13 road segments (polygon representation)
- **Infrastructure**: Cistern (64), Sewage (68) - reference only

Appendix C: Software Requirements

- PostgreSQL 12+ with PostGIS 3.x extension
- QGIS 3.x for visualization and data import
- pgAdmin 4 (optional) for database management

References

1. PostGIS Documentation. (2024). *Spatial and Geographic Objects for PostgreSQL*. https://postgis.net/docs/
2. QGIS Development Team. (2024). *QGIS Geographic Information System*. https://qgis.org/
3. PostgreSQL Global Development Group. (2024). *PostgreSQL Database Management System*. https://www.postgresql.org/

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