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## TECHNOGENIC SOILS IN TORUŃ

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Toruń is one of the oldest cities in Poland. The history of Toruń as an urban centre began on 18 December 1233 when the city rights were granted. In the Middle Ages, it was a prominent trade centre as a member of the Hanseatic League. Nowadays, because of the famous Gothic urban complex, the city is one of the most important and crowded tourist centres in Poland. The population of the city as of January 1<sup>st</sup> 2013 was 198 383 inhabitants. Toruń covers an area of 116 km<sup>2</sup>. It is located on the Vistula river, in the eastern part of the Toruń Basin (part of the Vistula ice marginal valley) in North Poland – 18°36' E and 53°01' N

(Fig. 1). The genesis of the Toruń Basin is associated with erosion and accumulation processes induced by meltwaters during the recession of the Weichselian ice sheet. There is a set of eleven river terraces in the described area, built of thick sand series. Within the terraces, vast dune complexes occur. The origin of surface feature transformation in the area of Toruń goes back to the 13<sup>th</sup> century with the highest intensity in the 19<sup>th</sup> and 20<sup>th</sup> centuries. Nowadays the largest areas in Toruń are represented by flat lands, which have developed as a result of filling of primary or secondary depressions and levelling of natural convex forms (e.g. dunes). Human activity generates the development of negative and positive land forms, which contribute to specific technogenic relief within the city limits (Podgórski 1996). Destructive morphological activity of man was present, among others, in the construction of roads, streets, channels and drainage ditches, and levelling surfaces, etc. The impact of human activity led to a gradual transformation

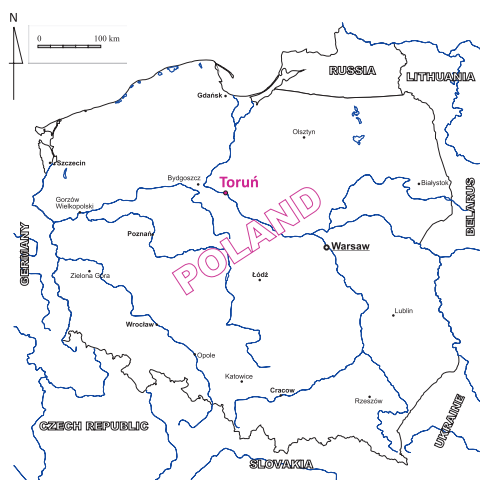


Fig. 1. Location of Toruń

of negative and positive land forms, which contribute to specific technogenic relief within the city limits (Podgórski 1996). Destructive morphological activity of man was present, among others, in the construction of roads, streets, channels and drainage ditches, and levelling surfaces, etc. The impact of human activity led to a gradual transformation

of aeolian forms and to the total elimination of small dunes. The thickness of surface embankments within the administrative boundaries of the city varies depending on their age. In the medieval area of the city and in the left-bank Podgórz district, there are 2.5–4.0 m thick embankments. On the outskirts of the Old Town, their thickness increases to about 7 m. The embankments with a thickness of 1.0–2.5 m occur within the boundaries of the 19<sup>th</sup> century city (Fedorowicz 1993).

The present state of urban soils in Toruń is a result of over 750-years of spatial development and an effect of human economic activity. The variety of technogenic soils can be found in Toruń: undisturbed and weakly transformed soils, urbisols, industrisols, garden soils, soils of parks and lawns, necrosols, ekranosols, constructosols and edifisols (Charzyński et al. 2013a). Urban forest soils (Podzols and Arenosols) cover about 23% of the city area. Changes in their morphology and properties are often relatively minor. Therefore, locally these soils can be classified even as natural. A large part of this area in the left-bank part of the city are military training grounds and locally soils are strongly transformed (Jankowski, Sewerniak 2013). The urban agricultural soils (mainly Fluvisols) are used as meadows, pastures and arable lands. They cover ca. 25% of the city area, but this value constantly decreases. Urbisols formed in the urban built-up area are characterised by varying degrees of morphological transformation. The soils occurring in the Old Town and downtown were formed on a well-developed cultural layer with the urbic horizon of a large thickness and high content of artefacts. The areas of relatively new housing estates are covered with incompletely developed urbisols. Toruń industry, and thus industrisols are concentrated in three parts of the city – western, north-eastern and southern. Allotment gardens in Toruń cover ca. 349 ha (3% of the total city area). The largest complex occurs in left-bank Toruń, in the Rudak quarter. Garden soils in Toruń cover a slightly larger area, because such soils can also be found in districts of detached houses. The soils of parks and grass plots cover 1.95% of the city area. Lawn soils are described by Charzyński et al. (2013b). There are 11 contemporary cemeteries in Toruń. Their soils – necrosols – were researched by Charzyński et al. (2011b). The largest homogeneous area of ekranosols in the city is located under the runway and taxiways of Toruń Aerodrome. Furthermore, ekranosols also occur under all asphalted or cemented streets, sidewalks and alleys in the city parks (Charzyński et al. 2011a, 2013d). Constructosols in Toruń are mainly represented by soils developed on forts (Jankowski et al. 2013) or some medieval walls, and soils of older sport grounds. Locally, edifisols can be found on some medieval structures and on ruined or badly maintained buildings (Charzyński et al. 2010, 2013c).

### **Acknowledgments**

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## Site 1 – Ekranic Technosol (Arenic)



**Location:** Central Communal Cemetery established in 1975, Toruń, northern Poland

**Coordinates:** 53°2'43.85" N 18°37'6.71" E

**Altitude:** 71.5 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** cemetery

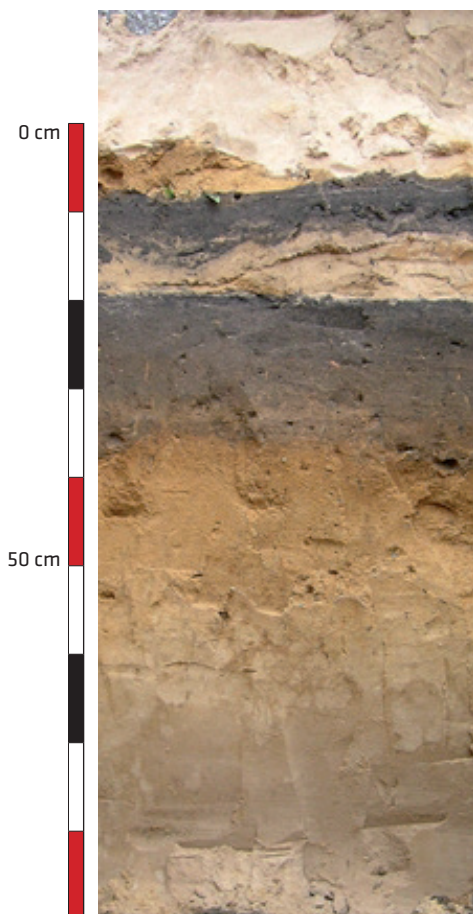
**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none

## Site 1 – Ekranic Technosol (Arenic)



### Morphology:

**Au – 0–11 cm:** sand, dark grey, single grain structure, slightly moist, clear boundary.

**Bu – 11–15 cm:** sand, light yellowish brown, single grain structure, slightly moist, abrupt boundary, common soft concretions of iron.

**Ab – 15–36 cm:** sand, greyish brown, granular structure, slightly moist, gradual boundary.

**Bw – 36–60 cm:** sand, greyish brown, single grain structure, slightly moist, diffuse boundary.

**C – below 60 cm:** sand, very pale brown, single structure, slightly moist.

### Comments:

25 years old grave.

## Site 1 – Ekranic Technosol (Arenic)

### Selected soil properties

HORIZON	Au	Bu	Ab	Bw	C	
DEPTH [cm]	0–11	11–15	15–36	36–60	>60	
<b>PARTICLE SIZE DISTRIBUTION</b>						
$\phi$ [mm]	[%]					
>2	1	2	5	2	0	
2.0–1.0	1	2	3	2	0	
1.0–0.5	9	15	14	15	4	
0.5–0.25	43	48	48	68	17	
0.25–0.1	44	28	25	13	76	
0.1–0.05	2	2	6	1	0	
0.05–0.02	1	2	2	1	1	
0.02–0.002	0	2	2	0	2	
<0.002	0	1	0	0	0	
<b>TEXTURE CLASS (USDA)</b>	sand	sand	sand	sand	sand	
<b>SOIL MATRIX COLOUR</b>	dry	10YR 4/1	10YR 6/4	10YR 5/2	10YR 6/6	10YR 8/3
	wet	10YR 2/4	10YR 4/4	10YR 3/2	10YR 4/6	10YR 6/3
<b>BULK DENSITY [g·cm<sup>-3</sup>]</b>	1.57	1.57	1.63	1.67	1.51	
<b>ACTUAL MOISTURE</b>	[% v/v]	2.7	6.4	7.8	2.8	3.2
	[% w/w]	4.3	10.1	12.7	4.7	4.9
<b>OC [%]</b>	0.98	–	0.50	–	–	
<b>N<sub>t</sub> [%]</b>	0.070	–	0.035	–	–	
<b>C:N</b>	14	–	14	–	–	
<b>P<sub>t</sub> [mg·kg<sup>-1</sup>]</b>	382	121	347	137	80	
<b>pH</b>	H <sub>2</sub> O	8.1	7.9	7.6	7.4	7.2
	1M KCl	7.6	7.0	6.6	6.1	6.0
<b>CaCO<sub>3</sub> [%]</b>	0.3	–	–	–	–	

## Site 2 – Urbic Technosol (Humic, Arenic)



**Location:** Sienkiewicza St., Toruń, northern Poland

**Coordinates:** 53°00'54" N 18°34'54" E

**Altitude:** 52 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** fallow.

**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** grasses, weeds

## Site 2 – Urbic Technosol (Humic, Arenic)



### Morphology:

**Au – 0–30 cm:** sand, dark greyish brown, granular structure, slightly moist, clear boundary, common roots, artefacts: charcoals, grout, pieces of bricks, glasses.

**Au2 – 30–95 cm:** sand, weak red, granular structure, slightly moist, common roots, dominant artifacts (pieces of bricks, glasses, plastic, metal, bones etc.; 80%), clear boundary.

**C – 95–130 cm:** sand, light brown, single grain structure, dry.

### Comments:

Site 2 was located in former Nicolaus Copernicus University botanical garden.

## Site 2 – Urbic Technosol (Humic, Arenic)

### Selected soil properties – site 2

HORIZON		Au	Au2	C
DEPTH [cm]		0–30	30–95	95–130
<b>PARTICLE SIZE DISTRIBUTION</b>				
ø [mm]		[%]		
>2		7	11	0
2.0–1.0		3	7	3
1.0–0.5		12	24	17
0.5–0.25		54	47	59
0.25–0.1		18	13	18
0.1–0.05		7	4	1
0.05–0.02		0	1	0
0.02–0.002		3	2	0
<0.002		3	2	2
<b>TEXTURE CLASS (USDA)</b>		sand	sand	sand
<b>SOIL MATRIX</b>	dry	2.5Y 4/2	2.5Y 4/2	10YR 6/3
<b>COLOUR</b>	wet	2.5Y 3/1	2.5Y 3/1	10YR 4/3
<b>BULK DENSITY [g·cm<sup>-3</sup>]</b>		1.41	–	1.65
<b>ACTUAL MOISTURE</b>	[% v/v]	9.5	–	2.2
	[% w/w]	13.1	–	3.7
<b>OC [%]</b>		1.49	2.64	0.20
<b>N<sub>t</sub> [%]</b>		0.103	0.128	–
<b>C:N</b>		14	21	–
<b>P<sub>ca</sub> [mg·kg<sup>-1</sup>]</b>		34	51	14
<b>pH</b>	H <sub>2</sub> O	7.6	7.7	7.6
	1M KCl	7.2	7.1	6.9
<b>CaCO<sub>3</sub> [%]</b>		0.5	0.8	
<b>HEAVY METALS SOLUBLE IN MIXTURE OF HF AND HClO<sub>4</sub></b>				
<b>Zn</b>		142	577	6
<b>Pb</b>	[mg·kg <sup>-1</sup> ]	<3	148	<3
<b>Cu</b>		<7	22	<7



**Site 2 – Urbic Technosol (Humic, Arenic)**

### Site 3 – Ekranic Technosol (Arenic)



**Location:** St. George Cemetery, Toruń, northern Poland

**Coordinates:** 53°0'58.79" N 18°35'40.35" E

**Altitude:** 53.5 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** cemetery

**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none

### Site 3 – Ekranic Technosol (Arenic)



#### Morphology:

**Au – 0–53 cm:** sand, dark grey, granular structure, slightly moist, common roots, gradual boundary.

**AC – 53–65 cm:** sand, brown, single grain structure, slightly moist, gradual boundary.

**C – 65–110 cm:** sand, very pale brown, single grain structure, slightly moist.

**AC (inclusion) – left side of C horizon:** sand, mixed with humus material, greyish brown, single grain structure, common roots.

#### Comments:

Site 3 was located in oldest Toruń cemetery (St. George Cemetery) existing since 1811.

## Site 3 – Ekranic Technosol (Arenic)

### Selected soil properties

HORIZON		Au	AC	C	AC (incl.)
DEPTH [cm]		0–53	53–65	65–110	65–110
<b>PARTICLE SIZE DISTRIBUTION</b>					
ø [mm]		[%]			
>2		4	0	0	0
2.0–1.0		2	1	1	1
1.0–0.5		17	12	6	16
0.5–0.25		57	61	63	60
0.25–0.1		19	23	27	19
0.1–0.05		1	0	3	3
0.05–0.02		2	1	0	0
0.02–0.002		2	2	0	1
<0.002		0	0	0	0
<b>TEXTURE CLASS (USDA)</b>		sand	sand	sand	sand
<b>SOIL MATRIX COLOUR</b>	dry	10YR 4.5/1	10YR 5/3	10YR 7/4	10YR 5/2
	wet	10YR 2.5/1	10YR 3/3	10YR 5/4	10YR 4/1
<b>BULK DENSITY [g·cm<sup>-3</sup>]</b>		1.46	1.66	1.60	1.52
<b>ACTUAL MOISTURE</b>	[% v/v]	5.5	2.4	2.4	3.3
	[% w/w]	8.0	4.1	3.9	5.0
<b>OC [%]</b>		0.69	–	–	0.50
<b>N<sub>t</sub> [%]</b>		0.049	–	–	0.035
<b>C:N</b>		14	–	–	14
<b>P<sub>t</sub> [mg·kg<sup>-1</sup>]</b>		472	126	115	292
<b>pH</b>	H <sub>2</sub> O	8.1	8.6	8.0	7.8
	1M KCl	7.6	8.3	7.3	7.4
<b>CaCO<sub>3</sub> [%]</b>		0.5	0.4	0.2	0.4

## Site 4 – Ekranic Technosol (Arenic)



**Location:** St. Jacob the Apostle Parish Cemetery established in 1817 Toruń, northern Poland

**Coordinates:** 53°59'32" N 18°37'35.31" E

**Altitude:** 62.5 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** cemetery

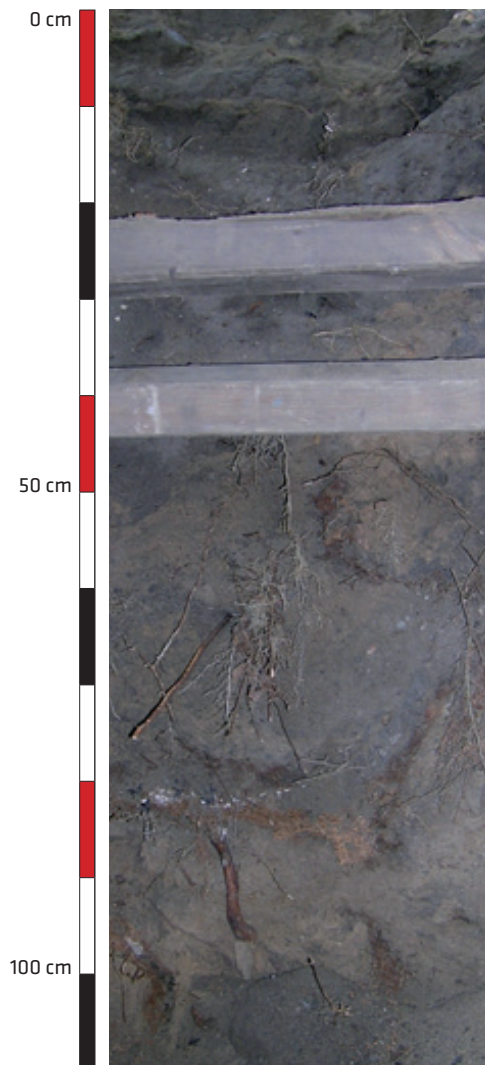
**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none

## Site 4 – Ekranic Technosol (Arenic)



### Morphology:

**Au – 0–60 cm:** sand, dark grey, single grain structure, slightly moist, very few roots, gradual boundary.

**AC – 60–85 cm:** sand, greyish brown, single grain structure, slightly moist, clear boundary.

**Bu – 85–90 cm:** sand, very pale brown, single grain structure, slightly moist, common artefacts (remains of coffin, part of chain, nails, bones etc. 5–15%), abrupt boundary.

**C – 90–100:** sand, brown, single grain structure, slightly moist.

## Site 4 – Ekranic Technosol (Arenic)

### Selected soil properties

HORIZON		Au	AC	C
DEPTH [cm]		0–60	60–85	90–100
<b>PARTICLE SIZE DISTRIBUTION</b>				
$\phi$ [mm]		[%]		
>2		5	2	4
2.0–1.0		4	2	4
1.0–0.5		8	9	7
0.5–0.25		47	50	46
0.25–0.1		31	32	35
0.1–0.05		3	3	3
0.05–0.02		4	3	1
0.02–0.002		1	1	4
<0.002		2	0	0
<b>TEXTURE CLASS (USDA)</b>		sand	sand	sand
<b>SOIL MATRIX COLOUR</b>	dry	10YR 4/1	10YR 5/2	10YR 5/3
	wet	10YR 2/1	10YR 3/1	10YR 3/2
<b>BULK DENSITY [g·cm<sup>-3</sup>]</b>		1.38	1.49	1.49
<b>ACTUAL MOISTURE</b>	[% v/v]	5.2	3.0	4.4
	[% w/w]	7.2	2.4	3.5
<b>OC [%]</b>		0.93	0.78	0.48
<b>N<sub>t</sub> [%]</b>		0.068	0.053	0.038
<b>C:N</b>		14	15	13
<b>P<sub>t</sub> [mg·kg<sup>-1</sup>]</b>		580	372	352
<b>pH</b>	H <sub>2</sub> O	7.2	7.1	7.3
	1M KCl	6.8	6.5	6.7
<b>CaCO<sub>3</sub> [%]</b>		–	–	–

## Site 5 – Urbic Ekranic Technosol



**Location:** Gałczyńskiego st., Toruń, northern Poland

**Coordinates:** 53°00'59.25" N 18°35'59.99" E

**Altitude:** 53 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** former parking

**Relief and lithology:**

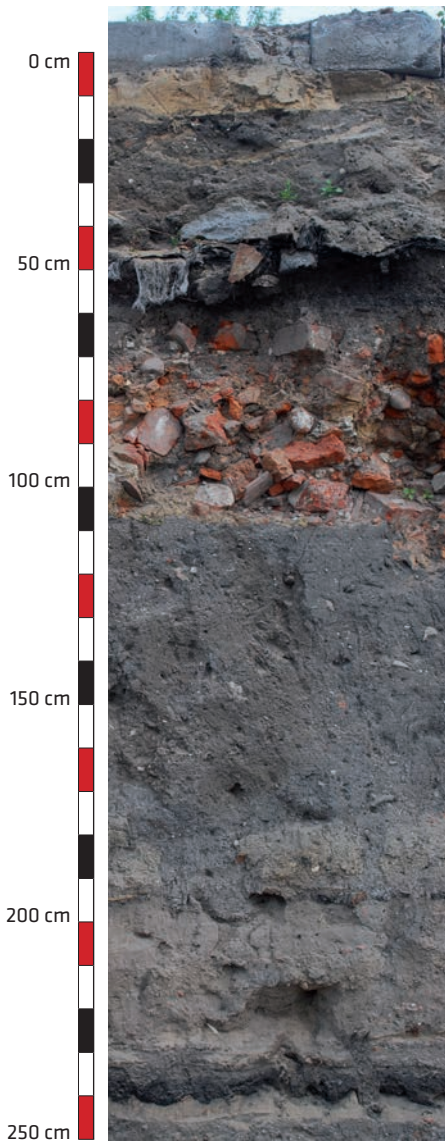
Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none



## Site 5 – Urbic Ekranic Technosol



### Morphology:

**Bu1 – 0–15 cm:** sand, light grey, single grain structure, slightly moist, dated for 20<sup>th</sup> century, abrupt boundary.

**Bu2 – 15–45 cm:** sand, light brownish grey, single grain structure, slightly moist, dated for 20<sup>th</sup> century, abrupt boundary.

**Bu3 – 45–55 cm:** layer consisting of rubbish: pieces of glass, polystyrene, bitumen etc., dated for 20<sup>th</sup> century, abrupt boundary.

**Bu4 – 55–65 cm:** sand, dark grey, single grain structure, slightly moist, dated for 20<sup>th</sup> century, abrupt boundary.

**Bu5 – 65–115 cm:** layer consisting of bricks fragments, dated for 19<sup>th</sup>/20<sup>th</sup> century, abrupt boundary.

**Bu6 – 115–180 cm:** loamy sand, greyish brown, granular structure, slightly moist, dated for 19<sup>th</sup>/20<sup>th</sup> century, clear boundary.

**Bu7 – 180–235 cm:** sand, light grey, single grain structure, slightly moist, dated for 19<sup>th</sup>/20<sup>th</sup> century, clear boundary.

**Bu8 – 235–245 cm:** sand, dark grey, single grain structure, slightly moist.

## Site 5 – Urbic Ekranic Technosol

### Selected soil properties

HORIZON	Bu1	Bu2	Bu4	Bu6	Bu7	Bu8	
DEPTH [cm]	0–15	15–45	55–65	115–180	180–235	235–245	
<b>PARTICLE SIZE DISTRIBUTION</b>							
$\phi$ [mm]	[%]						
>2	4	9	6	8	1	18	
2.0–1.0	2	4	4	3	1	10	
1.0–0.5	6	15	12	17	20	22	
0.5–0.25	12	32	42	35	54	29	
0.25–0.1	59	36	24	20	15	15	
0.1–0.05	18	6	5	8	1	3	
0.05–0.02	2	2	6	7	2	8	
0.02–0.002	1	3	5	9	4	13	
<0.002	0	2	3	1	3	0	
TEXTURE CLASS (USDA)	sand	sand	sand	loamy sand	sand	loamy sand	
SOIL MATRIX	dry	2.5Y 7/2	2.5Y 6/2	5Y 4/1	2.5Y 5/2	10YR 7/1	2.5Y 4/1
COLOUR	wet	2.5Y 4/4	2.5Y 4/2	5Y 1/1	2.5Y 3/2	10YR 7/2	2.5Y 2/2
OC [%]	0.14	0.52	4.21	1.39	2.64	0.75	
N <sub>t</sub> [%]	0.005	0.020	0.278	0.097	0.083	0.025	
C:N	28	26	15	14	32	30	
P <sub>t</sub> [mg·kg <sup>-1</sup> ]	200	541	2 590	4 180	1 880	2 060	
pH	H <sub>2</sub> O	8.0	8.2	7.7	8.1	8.0	8.1
	1M KCl	7.4	7.7	7.4	7.7	7.6	7.7
CaCO <sub>3</sub> [%]	0.2	3.2	2.2	7.3	0.7	22.7	
<b>HEAVY METALS SOLUBLE IN MIXTURE OF HF AND HClO<sub>4</sub></b>							
Pb	65	109	228	206	208	n.d.	
Cd	5	5	6	6	6	n.d.	
Zn	17	36	102	88	54	n.d.	
Cu	19	28	61	124	92	n.d.	

## Site 6 –Urbic Ekranic Technosol



**Location:** Szosa Chełmińska st., Toruń, northern Poland

**Coordinates:** 53°00'59.33 N 18°35'05.55" E

**Altitude:** 53 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** pavement

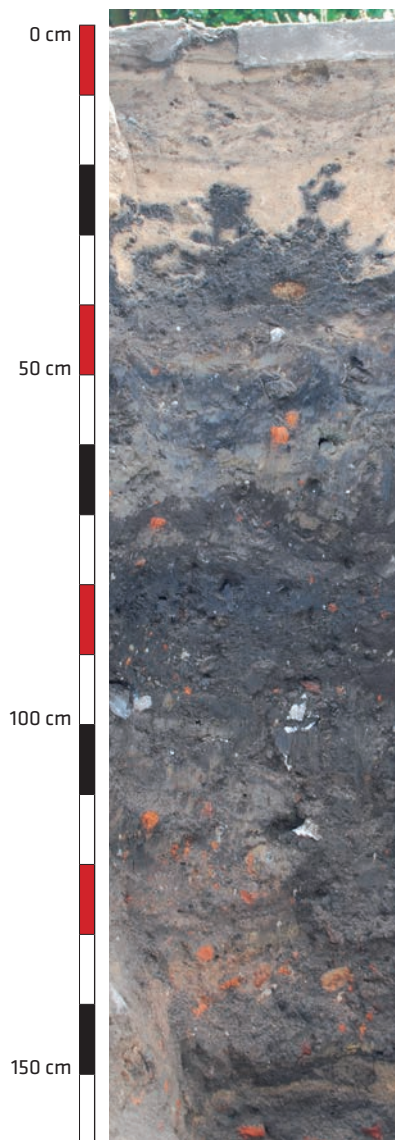
**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none

## Site 6 – Urbic Ekranic Technosol



### Morphology:

**Bu1 – 0–15 cm:** sand, light grey, single grain structure, slightly moist, gradual boundary, dated for the end of 20<sup>th</sup> century.

**Bu2 – 15–30 cm:** sand, light brownish grey, slightly moist, clear boundary, dated for 19<sup>th</sup>/20<sup>th</sup> century.

**Au1 – 30–39 cm:** sandy loam, light yellowish brown, granular structure, moist, gradual boundary, dated for 19<sup>th</sup>/20<sup>th</sup> century.

**Buh1 – 39–65 cm:** sandy loam, granular structure, light olive brown, slightly moist, gradual boundary, dated for 19<sup>th</sup>/20<sup>th</sup> century.

**Buh2 – 65–90 cm:** loamy sand, subangular structure, black, slightly moist, artefacts: pieces of bricks, gradual boundary, dated for 19<sup>th</sup>/20<sup>th</sup> century.

**Buh3 – 90–140 cm:** loamy sand, grey, subangular structure, slightly moist, artefacts: pieces of glass, polystyrene, bricks, gradual boundary, dated for 19<sup>th</sup>/20<sup>th</sup> century.

**Buh4 – 140–150 cm:** sandy loam, light brownish grey, granular structure, slightly moist, artefacts: pieces of bricks, dated for 19<sup>th</sup>/20<sup>th</sup> century.

### Comments:

Soil under the concrete pavement.

## Site 6 – Urbic Ekranic Technosol

### Selected soil properties

HORIZON	Bu1	Bu2	Au1	Buh1	Buh2	Buh3	
DEPTH [cm]	0–15	15–30	30–39	39–65	65–90	90–140	
<b>PARTICLE SIZE DISTRIBUTION</b>							
$\phi$ [mm]	[%]						
>2	2	2	0	0	7	14	
2.0–1.0	1	2	4	2	1	2	
1.0–0.5	21	25	9	9	10	14	
0.5–0.25	58	53	27	26	36	33	
0.25–0.1	16	16	31	32	37	23	
0.1–0.05	2	2	3	7	5	7	
0.05–0.02	0	0	4	3	2	4	
0.02–0.002	1	1	10	11	7	13	
<0.002	1	1	12	10	2	4	
<b>TEXTURE CLASS (USDA)</b>	sand	sand	sandy loam	sandy loam	loamy sand	loamy sand	
<b>SOIL MATRIX</b> dry	10YR 7/2	2.5Y 6/2	2.5Y 6/3	2.5Y 5/4	5Y 2/1	5Y 5/1	
<b>COLOUR</b> wet	10YR 5/2	2.5Y 4/2	2.5Y 3/2	2.5Y 4/2	5Y 2/1	5Y 4/1	
<b>OC [%]</b>	0.13	0.06	1.54	0.57	1.85	1.22	
<b>N<sub>t</sub> [%]</b>	0.002	0.000	0.055	0.030	0.098	0.042	
<b>C:N</b>	65	–	28	19	19	29	
<b>P<sub>t</sub> [mg·kg<sup>-1</sup>]</b>	249	165	1010	1830	784	1940	
<b>pH</b>	H <sub>2</sub> O	8.5	8.4	8.0	8.2	7.7	8.1
	1M KCl	8.2	8.1	7.4	7.3	7.3	7.4
<b>CaCO<sub>3</sub> [%]</b>	0.4	–	3.1	3.5	2.3	0.5	
<b>HEAVY METALS SOLUBLE IN MIXTURE OF HF AND HClO<sub>4</sub></b>							
<b>Pb</b>	63	18	67	181	318	63	
<b>Cd</b>	6	8	6	6	6	6	
<b>Zn</b>	18	–	54	27	40	16	
<b>Cu</b>	21	18	59	36	135	66	

## Site 7 – Urbic Ekranic Technosol (Calcaric)



**Location:** Szeroka st., Toruń, northern Poland

**Coordinates:** 53°00'37.67" N 18°35'26.12" E

**Altitude:** 49 m a.s.l.



photo J. Błaszkievicz

**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** sidewalk

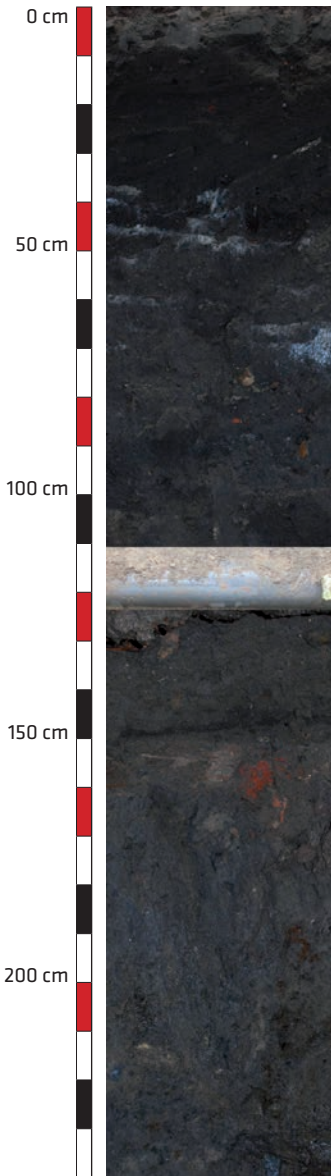
**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none

## Site 7 – Urbic Ekranic Technosol (Calcaric)



### Morphology:

**Buh1 – 0–18 cm:** sand, light grey, single grain structure, slightly moist, gradual boundary.

**Buh2 – 18–55 cm:** sand, light grey, single grain structure, slightly moist, few artefacts, gradual boundary.

**Buh3 – 55–110 cm:** sand, light brownish grey, single grain structure, slightly moist, clear boundary.

**Buh4 – 110–220 cm:** sand, grey, single grain structure, moist, many artefacts: pieces of brick.

### Comments:

Soil under the granite slabs on the main pedestrian street of Toruń Old Town.

## Site 7 – Urbic Ekranic Technosol (Calcaric)

### Selected soil properties

HORIZON	Buh1	Buh2	Buh3	Buh4	
DEPTH [cm]	0–18	18–55	55–110	110–220	
<b>PARTICLE SIZE DISTRIBUTION</b>					
$\phi$ [mm]	[%]				
>2	3	4	4	4	
2.0–1.0	7	6	4	3	
1.0–0.5	23	13	14	14	
0.5–0.25	37	41	40	41	
0.25–0.1	21	27	30	28	
0.1–0.05	3	4	5	4	
0.05–0.02	3	2	1	3	
0.02–0.002	5	5	6	6	
<0.002	1	2	0	1	
<b>TEXTURE CLASS (USDA)</b>	sand	sand	sand	sand	
<b>SOIL MATRIX</b>	dry	2.5Y 7/1	2.5Y 7/1	10YR 6/2	10YR 6/1
<b>COLOUR</b>	wet	2.5Y 3/4	2.5Y 3/4	10YR 3/4	10YR 3/4
<b>OC [%]</b>	0.44	0.04	0.84	0.60	
<b>N<sub>t</sub> [%]</b>	0.016	0.015	0.034	0.021	
<b>C:N</b>	28	26	25	29	
<b>P<sub>t</sub> [mg·kg<sup>-1</sup>]</b>	1180	898	1780	1880	
<b>pH</b>	H <sub>2</sub> O	9.0	8.1	8.1	8.1
	1M KCl	8.0	7.5	7.5	7.5
<b>CaCO<sub>3</sub> [%]</b>	2.4	2.1	1.3	1.0	



## Site 8 – Ekranic Technosol (Arenic)



**Location:** Rybaki Street, Toruń, Northern Poland

**Coordinates:** 53°00.537' N 18°35.078' E

**Altitude:** 48 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** pavement

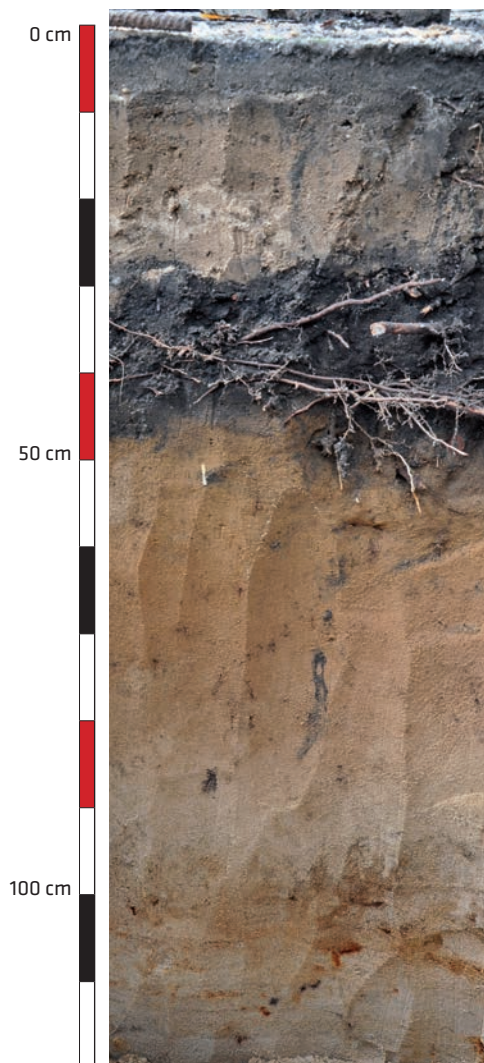
**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none

## Site 8 – Ekranic Technosol (Arenic)



### Morphology:

#### 0–5 – pavement tiles

**Bhu – 5–20 cm:** horizon enriched with organic matter, sand, yellowish brown, single grain structure, slightly moist, clear boundary, mixed material.

**Bu – 20–21 cm:** black bituminous layer.

**Ab – 21–40 cm:** buried humus horizon, sand, very dark grey, weak granular structure, slightly moist, clear boundary, common roots.

**Bw – 40–80 cm:** sand, very pale brown, single grain structure, slightly moist, few dead roots mottles, gradual boundary.

**Cl – below 80 cm:** sand, pale brown, single grain structure, slightly moist, common soft iron concretions.

### Comments:

Site located at Rybaki Street. It was sealed with concrete pavement tiles (stairs to park alley).

## Site 8 – Ekranic Technosol (Arenic)

### Selected soil properties

HORIZON	Bhu	Bu	Ab	Bw	Cl	
DEPTH [cm]	5–20	20–21	21–40	40–80	80–120	
<b>PARTICLE SIZE DISTRIBUTION</b>						
$\phi$ [mm]	[%]					
>2	6	–	26	1	0	
2.0–1.0	6	–	8	1	1	
1.0–0.5	19	–	17	10	15	
0.5–0.25	33	–	46	51	56	
0.25–0.1	35	–	15	20	24	
0.1–0.05	5	–	2	9	2	
0.05–0.02	2	–	4	5	1	
0.02–0.002	0	–	7	3	1	
<0.002	0	–	1	1	0	
TEXTURE CLASS (USDA)	sand	–	sand	sand	sand	
SOIL MATRIX	dry	10YR 6/4	7.5YR 3/1	7.5YR 4/1	10YR 8/2	2.5YR 8/3
COLOUR	wet	10YR 4/4	7.5YR 2.5/1	7.5YR 2.5/1	10YR 6/4	10YR 6/3
BULK DENSITY [g·cm <sup>-3</sup> ]	–	–	1.34	–	–	
ACTUAL MOISTURE	[% v/v]	–	–	15.9	–	–
	[% w/w]	–	–	11.9	–	–
OC [%]	0.43	12.5	7.50	0.19	0.04	
N <sub>t</sub> [%]	0.010	0.269	0.163	0.004	0.004	
C:N	43	46	46	47	10	
P <sub>t</sub> [mg·kg <sup>-1</sup> ]	122	134	86	109	97	
pH	H <sub>2</sub> O	8.2	6.9	7.6	7.4	7.3
	1M KCl	7.8	6.4	7.0	6.5	6.8
CaCO <sub>3</sub> [%]	1.2	trace	0.7	0.5	0.4	
<b>HEAVY METALS SOLUBLE IN MIXTURE OF HF AND HClO<sub>4</sub></b>						
Zn	6	197	221	<3	11	
Pb	<16	<16	47	59	<16	
Cd	<5	<5	<5	<5	<5	
Cu	<7	55	34	<7	<7	

## Site 9 – Ekranic Technosol (Arenic)



**Location:** Rybaki Street, Toruń, northern Poland

**Coordinates:** 53°00.537' N 18°35.078' E

**Altitude:** 48 m a.s.l.



**Climate:**

Average annual temperature: 7.5°C

Average annual precipitation: 600 mm

**Land-use:** asphalt alley

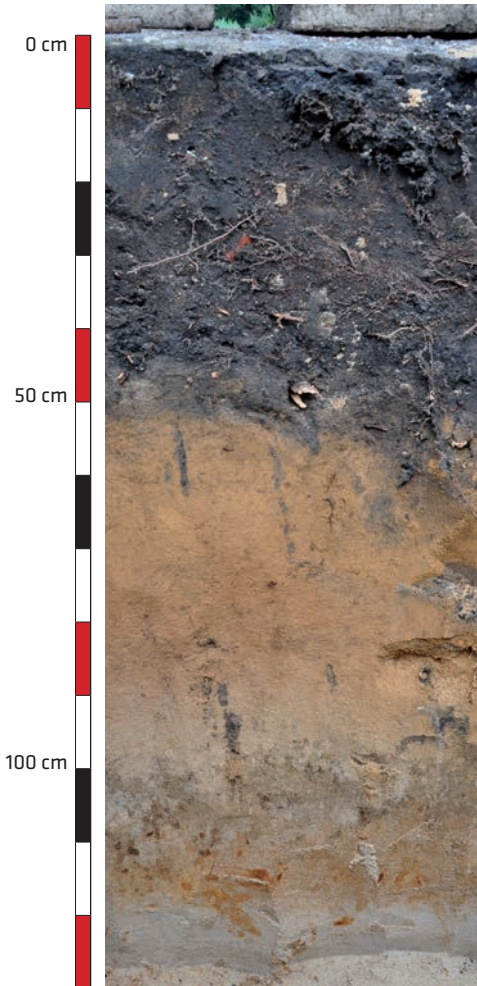
**Relief and lithology:**

Major landform: plain

Lithology: late Pleistocene fluvial sands

**Vegetation:** none

## Site 9 – Ekranic Technosol (Arenic)



### Morphology:

#### 0-8 – asphalt (bituminous) alley

**Bhu – 8-21 cm:** sand mixed with bitumens, dark grey, weak granular structure, slightly moist, gradual boundary.

**Ab – 21-40 cm:** buried humus horizon, sand, dark greyish brown, weak granular structure, slightly moist, clear boundary, common roots.

**Bw – 40-80 cm:** sand, very pale brown, single grain structure, slightly moist, few dead roots mottles, gradual boundary.

**Cl – below 80 cm:** sand, pale brown, single grain structure, slightly moist, common soft iron concretions.

### Comments:

Site located at Rybaki Street. It was sealed with hard bituminous layer (park alley).

## Site 9 – Ekranic Technosol (Arenic)

### Selected soil properties

HORIZON		Bhu	Ab	Bw	Cl
DEPTH [cm]		8–21	21–40	40–80	80–120
<b>PARTICLE SIZE DISTRIBUTION</b>					
$\phi$ [mm]		[%]			
>2		11	3	1	0
2.0–1.0		5	3	1	1
1.0–0.5		19	30	10	15
0.5–0.25		43	51	51	56
0.25–0.1		17	11	20	24
0.1–0.05		6	2	9	2
0.05–0.02		4	1	5	1
0.02–0.002		4	2	3	1
<0.002		2	0	1	0
TEXTURE CLASS (USDA)		sand	sand	sand	sand
SOIL MATRIX	dry	10YR 4/1	10YR 4/2	10YR 8/2	2.5YR 8/3
COLOUR	wet	10YR 2/1	10YR 3/2	10YR 6/4	10YR 6/3
BULK DENSITY [g·cm <sup>-3</sup> ]		–	1.49	–	–
ACTUAL MOISTURE	[% v/v]	–	15.4	–	–
	[% w/w]	–	10.3	–	–
OC [%]		4.54	1.30	0.19	0.04
N <sub>t</sub> [%]		0.148	0.057	0.004	0.004
C:N		31	23	47	10
P <sub>t</sub> [mg·kg <sup>-1</sup> ]		247	344	109	97
pH	H <sub>2</sub> O	6.9	7.9	7.4	7.3
	1M KCl	6.2	7.6	6.5	6.8
CaCO <sub>3</sub> [%]		trace	0.8	0.3	0.4
<b>HEAVY METALS SOLUBLE IN MIXTURE OF HF AND HClO<sub>4</sub></b>					
Zn		78	20	<3	11
Pb		64	<16	59	<16
Cd	[mg·kg <sup>-1</sup> ]	<5	<5	<5	<5
Cu		23	10	<7	<7