Leslie Carr-Riegel

Waste management in medieval Krakow: 1257-1500

MA Thesis in Medieval Studies

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by

Leslie Carr-Riegel

(The United States of America)

Thesis submitted to the Department of Medieval Studies,
Central European University, Budapest, in partial fulfillment of the requirements
of the Master of Arts degree in Medieval Studies.

Accepted in conformance with the standards of the CEU.

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I, the undersigned, L**eslie Carr-Riegel**, candidate for the MA degree in Medieval Studies, declare herewith that the present thesis is exclusively my own work, based on my research and only such external information as properly credited in notes and bibliography. I declare that no unidentified and illegitimate use was made of the work of others, and no part of the thesis infringes on any person's or institution's copyright. I also declare that no part of the thesis has been submitted in this form to any other institution of higher education for an academic degree.

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Abstract

This thesis outlines the wastes produced in medieval Krakow - Animal, Industrial, and Domestic – and the efforts made to control them between the dates of the city's incorporation under Magdeburg law in 1257 up to 1500. Applying a cross-disciplinary approach to the subject, civic notary books, chronicles, literature, archaeological evidence, art, and modern chemical analysis are all utilized to draw a picture of what waste in Krakow was like during the medieval period. Chapter one covers the city government's efforts to manage waste build-up in Krakow, the insufficiencies of which lead to the continued rise of the city's street level until the sixteenth century. This management is compared with that of other polities and shows that although the city developed impressive infrastructure, civic leaders failed to implement sufficient legislation, enforcement, and public services to keep Krakow clean. In chapter two, industrial waste is discussed focusing on the most noxious trades - metallurgy, tanning, meat processing, and textile manufacture – detailing contemporary knowledge of the harmful effects of these activities and efforts made to manage them. Chapter three focusses on domestic waste and outlines how residents dealt with rubbish in everyday life.

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First, thanks to God, the rock of ages, my redeemer and sustainer who is ever by my side in times of trial and to whom I offer these first fruits. Next, thank you to my loving husband Karol Nowoszynski who has given me unending support with translation, creating graphics, and keeping me sane. To my parents, for spending hours helping me with edits and ideas and for always encouraging me to do the work I love even though it takes me far away. To my advisory Gerhard Jaritz who helped so much in translating Krakow's medieval German statutes and provided excellent pointers and advice. To Zsuzsa Reed who assisted in editing and for my many colleagues who listened for hours as I droned on about waste and gave helpful suggestions on how to improve. Thanks to you all.

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Introduction

Krakow: A Brief Introduction

In 1257, the city of Krakow was granted a charter of incorporation under Magdeburg law by Duke Bolesław V the Chaste of Poland. The site had been the capital of the nascent Polish kingdom since the eleventh century but had been all but levelled in a Mongol raid in 1241. With a nearly blank slate to work with, Bolesław V laid out a new town on a rational grid complete with a grand central market, one of the largest in Europe, to spread below his castle on Wawel Hill. The adoption of Magdeburg law and subsequent favorable trade privileges made the city an attractive proposition for settlement. Over the next three hundred years many German speaking merchants and craftsmen, together with Jews, Italians, and other peoples settled amongst the Poles already inhabiting the city. The site prospered in the shadow of the Wawel with the presence of the royal court providing a constant economic engine. By the early fifteenth century, Krakow was an impressively fortified city, the capital of the burgeoning Polish kingdom, and an important trade emporium. As the city's population grew, however, so too did the amount of waste its inhabitants produced. The build-up of rubbish became increasingly problematic and the City Council and individual residents struggled to find ways to manage the problem. For the next two centuries, minimal legislation, limited enforcement, and inadequate public services would leave Krakow a remarkably dirty city by the standards of the day, even in the midst of its *Złoty wiek* (Golden Age). Change came in the sixteenth century but just as things were improving, in 1596 the Polish throne having fallen to the Vasa dynasty, the capital of Poland was moved to Warsaw. Krakow's star went into eclipse and was almost snuffed out by the "Swedish Deluge" during the next century which pounded the city's

infrastructure back to the thirteenth century. Krakow never fully recovered from the invasion, its population plunged, and it remained a relative backwater until the coming of the modern period.

The following paper will argue the case made above by laying out the types of waste common to Krakow and methods used to deal with them. Chapter one focuses on civic waste: Krakow's contemporary dirty reputation, the evolution of its infrastructure, and its authorities' largely unsuccessful attempts to combat rising pollution into the sixteenth century. Chapter two looks specifically at industrial pollution, the most problematic guilds, the effects of their waste on the people of Krakow, the medieval perception of pollutants, and attempts to control these perceived problems. [1] Chapter three examines domestic waste: refuse generated in the home, how it was disposed of, and attempts made to limit its production. This thesis will show that while Krakow developed an impressive public infrastructure, its civic authorities failed to implement many of the waste management strategies adopted by other cities which led to a continuing build-up of problematic rubbish into the sixteenth century. In an effort to limit the scope of this work I have not included medieval Krakow's two satellite communities of Kazimirz and Kleparsz or the state of affairs on Wawel Hill, confining the focus to the city's 1257 incorporation borders.

Literature Review

In recent years, questions revolving around medieval waste management have received increased attention from scholars. Excellent works dealing with waste in the urban environment have been published in English by Lynn Thorndike, Ernest Sabine, Derek Keene, Roberta Magnusson, Robert Laures and Ronald Zupko, Gerhard Jaritz, Chris Croly, and Dolly

[1] For this section I will conflate waste with pollution. While the two might be judged differently, I am here defining pollution as the result of an unintended negative bi-product of industrial processes.

Jørgensen.[2] While some of these publications have approached waste management as a general topic generally, many more have been case studies focused on a specific region in Western and Northern Europe. However, interest in environmental history has also been expanding to the east as recent local conferences and the large *Ecology of Crusading* project (2010-2014), which focused on the medieval Baltic demonstrate.[3] In Poland, questions surrounding the history of waste have been pushed forward primarily by archeologists, Jerzy Piekalski, Dariusz Nimiec, and Paweł Cembrzyński chief among them.[4] While on the historical side, our understanding of the workings of medieval Poland's water systems has greatly advanced by Urszula Sowina's recent work.[5] Still, because a rather dark veil of mystery yet shrouds scholarship of Central and Eastern Europe for English researchers, in an effort to expand the field of knowledge on medieval waste I have chosen to present the following case study on the city of Krakow. Translations from Polish works have been made by me with the assistance of Karol

[2] Ernest L. Sabine, "Butchering in Mediaeval London," *Speculum* 8, no. 3 (1933): 335–53, doi:10.2307/2848862. Lynn Thorndike, "Sanitation, Baths, and Street-Cleaning in the Middle Ages and Renaissance," *Speculum* 3, no. 2 (1928): 192–203, doi:10.2307/2848055; Derek J. Keene, "Rubbish in Medieval Towns," in *Environmental Archaeology in the Urban Context*, (London: Council for British Archaeology,1982), 26–30; Roberta J. Magnusson, *Water Technology in the Middle Ages: Cities, Monasteries, and Waterworks after the Roman Empire* (Baltimore: JHU Press, 2001); Ronald Edward Zupko and Robert Anthony Laures, *Straws in the Wind: Medieval Urban Environmental Law: The Case of Northern Italy* (Boulder, CO: Westview Press, 1996); Gerhard Jaritz, "Excrement and Waste," in *Handbook of Medieval Culture*, vol. 1, ed. Albrecht Classen (Berlin: Walter de Gruyter, 2015); Chris Croley, *Privies and Other Filthiness…: The Environment of Late Medieval Aberdeen c. 1399-1650.* (Aberdeen: Aberdeen City Council, 2003); Dolly Jørgensen, "Cooperative Sanitation: Managing Streets and Gutters in Late Medieval England and Scandinavia," *Technology and Culture* 49, no. 3 (2008): 547–67.

[3] *The Ecology of Crusading, "The Environmental Impact of Conquest, Colonisation and Religious Conversion in the Medieval Baltic,"*, accessed May *3*, 2016. *http://www.ecologyofcrusading.com* A conference was held on the topic in Gdansk, Poland in 2004. For a detailed description of the conference papers and participants who have gone on to publish other related works see: Urszula Sowina, "Gutters, Latrines and Closets: Sanitation Problems in Central-European Towns in Medieval and Early Modern Times," *Acta Poloniae Historica* 92 (2005): 317-18.

[4] Jerzy Piekalski, *Prague, Wrocław and Krakow: Public and Private Space at the Time of the Medieval Transition* (Wrocław: Uniwersytet Wrocławski Instytut Archeologii, 2014); Paweł Cembrzyński, *Zaopatrsenie w wode I usuwanie nieczystości w miastach stref Bałtyckiej I sudecko-karpackiej w XIII-XIV wieku* [Water supply and waste disposal in the cities of the Baltic and Sudenten-Carpathian zones in the thirteenth-sixteenth centuries] (Wrocław: Instytut Archeologii Uniwersytetu Wrocławskiego, 2011); Dariusz Niemiec, "Bruki na placach i ulicach średniowiecznego zespołu miejskiego Kraków-Kazimierz-Kleparz" [Pavements of squares, and streets in the medieval city complex of Krakow: Kazimierz-Kleparsz], *Wratislavia Antiqua*, vol. 13, (Wrocław: Uniwersytet Wrocławski 2011).

[5] Urszula Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," *Fasciculi Archaeologiae Historicae* 24 (2011): 11–18.

Nowoszynski while those from German were done with the generous help of my supervisor Gerhard Jaritz.

Primary Sources

In a bid to understand how waste was managed in Krakow during the medieval period I have mined numerous primary sources for information. These included city privileges, laws, guild statutes, notary books, financial records, chronicles, poems, visual art pieces, and some limited personal correspondence. I regret that I have so far only been able to work with published sources but thankfully, many of the records relating to the history of the city of Krakow were transcribed and edited in the nineteenth and early twentieth century and are readily available. The sources I have consulted for the project include the: *Kodeks dyplomatycny miasta Krakowa* [Diplomatic book of the city of Krakow], which records the many privileges granted to the city, statutes issued by the city council, and numerous other reports related to civic events.[6] Similar in scope but with extra additions are the *Najstarsze księgi i rachunki miasta Krakowa od R. 1300 do 1400.* [The oldest books and accounts of the city of Krakow from 1300 to 1400] and the *Najstarszy zbiór przywilejów i wilkierzy miasta Krakowa* [The oldest set of privileges and laws of the city of Krakow].[7] I have also consulted the *Cracowia Artificum,* which contains collated archival records related to the city's guilds and secondary works which contain otherwise unavailable transcribed editions of specific guild statutes.[8] The financial records of

[6] *Kodeks dyplomatyczny miasta Krakowa 1257-1506* vol. 1/2 [Records of the City of Krakow 1257-1506], ed. Franciszek Piekosiński (Kraków: Akad. Umiejętności, 1879).

[7] *Prawa przywileje i statuta miasta Krakowa (1507-1795)* [Laws, priviliges and statutes of Krakow 1507-1795], ed. Piekosiński, Franciszek (Krakow: Nakl. Akademii Umiejtnoci Krakowskiej, 1885);*Najstarszy zbiór przywilejów i Wilkierzy miasta Krakowa* [The oldest set of privileges and laws of the city of Krakow], ed. Stanisław Estreicher (Krakow: Nakladem Polskiej Akameji Umiejetnosci, 1936).

[8] *Jan Ptaśnik and Stanisława Pańków, eds, Cracovia Artificum: 1300-1500 (Krakoow: Polska Akademia Umiejętności, 1917);* Michał Schmidt, "Sadownictwo Cechow Krakowskich w seredniowieczu w swietle ksiag cechowych" [Jurisdiction of craft guilds in medieval Krakow presented in guild books], *Prace Historyczne* 142, no. 1 (2015): 61-77; Kazimierz Sękowski, "Statuty krakowskiego cechu konwisarzy i ludwisarzy z roku 1412 i 1512 jako źródło do historii techniki" [Statutes of the Krakow guild of konwisarzy and bell-founders from 1412

the Krakow city council have survived in fragmented runs and have yet to be published. However, a thorough evaluation and summary of their contents was published by Stanisław Kutrzeba and I have used this in my analysis.[9] Looking for court records from the period I was disappointed only to find the *Księga proskrypcji i skarg miasta Krakowa: 1360-1422; ze zbiorów Archiwum Państwowego w Krakowie* [Book of complaints and the proscriptions of the city of Krakow: 1360-1422; from the collections of the State Archives in Krakow], a set of trial decisions from the period which contained disappointingly few waste relatable cases. [10] To examine the changes which occurred in the sixteenth century I consulted the correspondence of the *Polish King Sigismund I within the Acta Tomiciana,* and the *Księga wiertelnicza krakowska / Quartaliensium recognitiones et divisiones 1568-1577* , which describes a series of annual audits conducted of Krakow's architecture initiated in that year.[11] Finally, I have also made use in my analysis of various paintings from the period and the images contained in the *Balthazar Behem Codex*, which from 1505 registered the city's privileges and guild charters and includes more for the twenty-eight miniatures showing the type of work performed by each guild.[12]

and 1512 as a source for the history of technology], *Kwartalnik Historii Nauki i Techniki* 29, no. 2 (1984): 399–430.

[9] Stanisław Kutrzeba, *Finanse Krakowa w wiekach średnich* [Krakow's finances in the Middle Ages] (Krakow: Drukarnia ""zasu" Fr. Kluczyckiego i Spółki, 1899).

[10] Bożena Wyrozumska, ed., *Księga proskrypcji i skarg miasta Krakowa 1360-1422 / Liber proscriptionum et querelarum civitatis Cracoviensis 1360-1422*, Fontes Cracovienses 9. (Krakow: Towarzystwo Miłośników Historii i Zabytków Krakowa, 2001).

[11] Urszula Sowina's work pointed me to this valuable source. *Piotr Tomicki and Stanisław Górski, ed.. Acta Tomiciana, vol. 15. (Poznan: Sumptibus Instituti Nationalis Ossoliniani, 1957);* Jelonek-Litewka, Krystyna, Aleksander Litewka, and Łukasz Walczy, eds, *Księga wiertelnicza krakowska / Quartaliensium recognitiones et divisiones; 1568-1577* [Quarter books of the city of Krakow 1568-1577], vol. 1. (Krakow: TMHiZ, 1997).

[12] *Baltazar Behem, Codex picturatus Balthasaris Behem: Facsimile, (Krakow: Krajowa Agencja Wydawnicza, 1988).*

Research Questions

What were the wastes present in medieval Krakow? How were they perceived? How were they managed in the period? Why were they managed in this way? What effect did wastes have on the lives of people living in Krakow at the time?

Methodology

In order to present as complete a picture as possible of what waste issues were like in medieval Krakow, I have sought to incorporate both standard historical documents and sources that range beyond the limits of history as a traditional discipline. Waste in itself is a historical construct of the society it is created by. One person's trash really can be another's treasure and attitudes defining cleanliness and pollution, useful and useless, change across time and culture. In order to try to understand what, why, and how waste was viewed in medieval Krakow, I have utilized archeological reports, normative sources from the time and as well as more colorful depictions from firsthand accounts and art. At the same time, in order to understand how wastes from certain industrial activities and biological contamination would have affected people, perhaps without their knowledge, I have applied modern scientific research. By blending these approaches I hope to give a more rounded view of what waste in medieval Krakow would have been like for the individuals at the time and for any modern historian who happened to stumble upon the scene. I have also sought to show how Krakow's infrastructure and waste management strategies changed overtime following its evolution from the city's official incorporation in 1257 through the sixteenth century. I have also adopted a comparative approach to assess Krakow's managerial success relative to other polities during the period.

Chapter 1 – Civic Waste Management

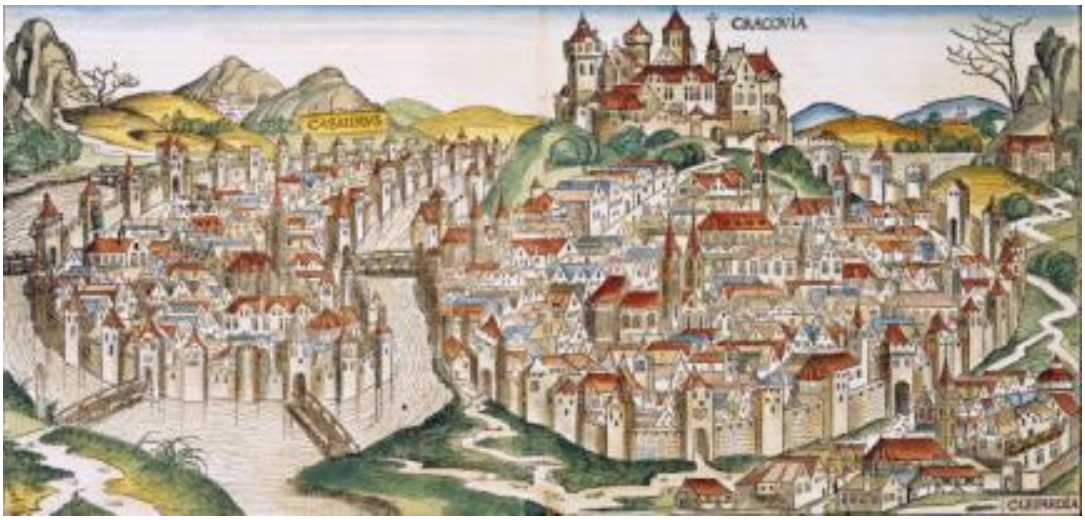


Figure 1: Cracovia
(Nuremberg Chronicle 1493 Woodcut View facing west, with Kazimierz on the left Wikimedia Commons https://en.wikipedia.org/wiki/History_of_Krak%C3%B3w#/media/File:Nuremberg_chronicles_-_CRACOVIA.png)

In 1426, Stanisław Ciołek, a court treasury official of the Polish king penned *Cracovia civitas* (In praise of Krakow).[13] The first four stanzas praise the city while the rest extol the Polish royal family and ask for God's blessing on the state. Of the city, Ciołek says,

> "O, city of Krakow, the unity
> Of your inhabitants abundantly
> Serves as your adornment:
> A multitude of clergy, dignity of men,
> And matrons with a great many children;
> Riches in profusion.
>
> You are washed by clear springs,
> Guarded by shade-giving hills.
> The guilty will not escape retribution,
> The innocent will receive benefaction,
> Everyone will encounter compassion.
>
> In your walls rest the holy remains

[13] I have seen the title of this work rendered in Polish as *Pochowała Krakowa* and in English variously as Song of Krakow and Praise of Krakow which appears to better reflect the spirit of the work behind the Latin title line rather than a word for word translation. For more on the life and work of Stanisław Ciołek, see Piotr Górecki and Nancy van Deusen, *Central and Eastern Europe in the Middle Ages: A Cultural History* (London: I.B.Tauris, 2009), 158–59.

Of Stanisław; the monks
Guard this relic like a treasure
In a magnificent shrine.
Here Jadwiga, mother of mothers,
Nearing her last moments of life
Takes great satisfaction.

The flower of knighthood, the scourge of enemies,
Shines with courage at your gates;
Chivalry rules everywhere.
When you hear a chant of singers
Sadness turns to soothing sweetness -
Without hostility, without wickedness
You will dance in innocence."[14]

The aspects of the city Ciołek here chooses to emphasize are the unity, piety, and valor of its citizens while very little is said about the city's physical characteristics. Indeed, all that can be attained from the poem is that the city is surrounded by a wall pierced by multiple gates, "washed by clear springs" and "guarded by shade-giving hills." A description so generic that it could apply to nearly any town in medieval Europe. Ciołek's focus in this work was obviously not to highlight the city's infrastructural achievements. This choice, may have been made for specific political reasons of the time, but in leaving out such a description, Ciolek breaks with the predominant form of urban panegyric best embodied by his near contemporary Leonardo Bruni, and his *Laudatio Florentinae Urbis*, describing the city of Florence. Bruni's effusive praise of his home city is entirely centered upon the glories of its piazzas, the beauty of its buildings, and the cleanliness of its streets. Indeed, he says, "[e]veryone knows that a city wanting in beauty, lacks the most precious gem" and that, "[e]ven if they would have a thousand palaces, even if the riches would be beyond measure, nevertheless I shall feel contempt for a dirty city."[15] The gulf between these two works begs the question of why Ciołek chose to speak so little about the delights of Krakow's streets.

[14] Michael J. Mikoś, *Medieval Literature of Poland: An Anthology* (New York: Garland, 1992) accessed April 30, 2016, http://www.staropolska.pl/ang/middleages/sec_poetry/Ciolek.php3.
[15] Bruni continues: "But Florence is clean and swept, so that nowhere can be found anything better tended. This city is certainly unique, a city which displays nothing offensive to the eyes, nothing to irritate the nostrils, nothing

Indeed, Ciołek is far from the only source which calls Krakow's cleanliness into question. The description of Krakow given in the famous *Liber Chronicarum*, the Nuremberg chronicle (Fig. 1) composed in 1493 reads,

> In the beginning this city was surrounded by battlements, bow-windows, bulwarks, and high towers; later by a *small dilapidated ancient wall*, and finally by earth works and a moat. Some of these *moats were filled with fishing-waters, and others given up to shrubbery*. A river, the Rudis (Rudawa), flows about the entire city and drives mill-wheels. By means of canals and conduits it is carried to all parts of the city. This city has seven gates and many beautiful and spacious residences; also many large church edifices, the most distinguished being that of Our Lady, which has two high towers and is located in the heart of the city.[16]

Aside from the walls needing a bit of a spruce up and moat being a tad overgrown, this description does not appear too uncomplimentary until one compares it with the next city in the chronicle, Lubeck.

> This city is *sanitary* and *cleanly*, sloping from the heights into a valley so that *water and impurities flow off freely*. The streets and lanes are *kept clean* by frequent rains. The cathedral at the north end of the city is spacious and beautiful. There are also four parish churches, with seven tall gilded spires, beautiful towers, and roofs covered with copper and lead…The city is protected and fortified by water, walls, towers, and moats. It has two long and broad streets, bordered by beautiful spacious houses built of brick. These houses observe a uniform position, so that one does not project beyond the other.[17]

dirty thrown before the feet. The industrious citizens have taken care of everything things are arranged thus, that while dirt is cleaned up, you only encounter those things that bring joy and are pleasuring to the senses. Therefore the grandeur of the town without a doubt, surpasses that of all other cities of our days. But as regards shining cleanliness this city does not only surpass all present cities, but, no doubt, also those of the past. For a like hygiene is unheard of and hard to believe for those who have never seen Florence. The admiration grasps even us who live in this city every day. Even habituation cannot saturate us." Leonardo Bruni, *In Praise of Florence: The Panegyric of the City of Florence and an Introduction to Leonardo Bruni's Civil Humanism,* trans. Alfred Scheepers (Amsterdam: Olive Press, 2005), 80.

[16] Hartman Schedel, *First English Edition of the Nuremberg Chronicle*, trans. Walter W. Schmauch (Madison, WI: University of Wisconsin Digital Collection Center, 2010), accessed April 3, 2016, http://digital.library.wisc.edu/1711.dl/nur.001.0004. Appenda 3A11.74.

[17] Emphasis is author's own. *First English Edition of the Nuremberg Chronicle*, Appenda 3A11.74.

Here Lubeck, meets Bruni's high bar for a beautiful city. It is sanitary, washed clean, beautiful and well-fortified. By comparison, the description of Krakow in its omission of these characteristics implies that the city falls short of the imagined glorious cleanliness so praised in depictions of cities during the fifteenth century. Other evidence points to this conclusion as well. The humanist cleric, Conrad Celtis, who studied at the University of Krakow from 1488-90, in his poem *Fünf Bücher Epigramme* lambasted the city for the piles of muck which accumulated in its streets saying,

> As the Trans/alpine Gaul country sinks in the mud,
> so is our borough Krakow sinking ever deeper,
> Its hideous streets are only sparsely paved/cobbled,
> and a 4-horse carriage up to its axel gets stuck in the mud.[18]

A description likely exaggerated for dramatic effect but one which archeological evidence gives some credence to as Krakow's street level continued to rise, up to the sixteenth century.[19] The most damning evidence of Krakow's sorry hygienic state comes from the king himself, who in 1533, complained of the most iconic image of medieval uncleanliness, the tossing of chamber pot contents from upper-story windows. The king was disheartened that visitors might feel "extremely offended by these impurities gathered on the streets that for the most

[18] I have had great difficulty accessing the original German text, the translation to English comes from a Polish translation of the German original:: Jak Cisalpińskiej kraj Galii w gnijącym topi się błocie, Tak i krakowski nasz gród w błocie zanurza się wciąż, Jego szkaradne ulice gdzieniegdzie tylko bruk mają, Zaprzęg poczwórny po oś grzęźnie w lepkości błot. See: Antonina Jelicz, *Życie codzienne w średniowiecznym Krakowie: wiek XIII-XV* [Everyday life in medieval Krakow: thirteenth to fifteenth centuries] (Warsaw: Państwowy Instytut Wydawniczy, 1966), 72–78. Celtis did, however, enjoy the city's women, food and the beer. See: Harold B. Segel, *Renaissance Culture in Poland: The Rise of Humanism, 1470-1543* (Ithaca N.Y.: Cornell University Press, 1989), 92-94.

[19] In comparing the levels of debris accumulation between the cities of Prague, Wroclaw and Krakow, Jerzy Piekalski and his team found that while the ground levels of Prague and Wroclaw stabilized during the thirteenth and fourteenth centuries respectively, Krakow's ground level continued to build up until the sixteenth century. The cobbled streets of the city analyzed during the dig, "rested under layers of waste and dirt, which was interpreted as humus or muck." Jerzy Piekalski, *Prague, Wrocław and Krakow: Public and Private Space at the Time of the Medieval Transition* (Wrocław: Uniwersytet Wrocławski. Instytut Archeologii, 2014), 152. It is possible that some of the rubbish and waste identified by archeologists as a sign that Krakow's streets were particularly disgusting was put there intentionally by medieval residents in a purposeful attempt to raise and level the roadway. Dolly Jørgensen, in her work has identified examples of this technique in other medieval cities and it is possible this was the case as well in Krakow. This reading however, is not the opinion of the author. The way in which the cultural layers were presented in having built up in archeological reports points to a slow accumulation overtime, rather than a single dump. As well, porches of houses which were built at earlier times were buried entirely as the street level rose making them unusable, something a doubt residents would have agreed to voluntarily. Jørgensen, "Cooperative Sanitation," 560.

part are poured through the windows at night."[20] All of this appears to suggest that Krakow was a particularly dirty city in its day; for while each individual piece of evidence is not definitive, taken as a whole they paint a compelling image of a city mired in muck. Yet, for a flourishing capital how can this be explained in a time when rulers and residents of towns measured prestige through cleanliness? What was the state of Krakow's infrastructure during the period? Did the civic authorities not attempt to alleviate the situation?

I will argue in the following section that the state of Krakow's infrastructure was not entirely without merit but for a variety of reasons the city failed to meet the civic humanist standard of cleanliness. Indeed, it was almost entirely through infrastructure improvement projects that the civic authorities sought to control the waste in its environment. As will be discussed, the city council implemented some limited legislation regarding clean up and waste removal but had few means for enforcing these restrictions, and unlike other European cities of the time, Krakow had no organized trash collection. Instead, they focused on expanding infrastructure to make cleaning easier and then relied upon the good will of its citizens not to dump rubbish in the streets. Human nature, however, and the force of the collective goods dilemma doomed this plan to failure. Yet, it must be remembered that throughout the period Krakow remained a relatively small place, a city with its population never rising above 18,000.[21] Throughout its pre-modern history, it appears that the population density was such that the natural waste sinks of the environment were able to cope with the load; things might not have been pleasant but they were never so dire that a push for change became overwhelming. Only in the sixteenth

[20] For the Latin text of the entire letter see: *Acta Tomiciana*, 414-15, No. 301.

[21] Estimates tabulated from "Peter's pence" in 1340 put the number of the people in Krakow at around 12,000, with that number bumped up to 13-14,000 if the people living in Kazimierz are included in the figure. In the year 1500 Krakow had an estimated population of around 15,000. This number rose during the next fifty years until estimates put the population at about 18,000 by the mid- sixteenth century. The city fell into decline after removal of the court to Warsaw in 1596 and fell on really hard times in the wake of the Swedish invasion in the mid-seventeenth century which among other things destroyed most of its piped-water infrastructure. By the eighteenth century the population of Krakow had declined to about 10,000. F. W. Carter, *Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 1795* (Cambridge: Cambridge University Press, 2006), 4–5.

century did a shift away from this torpid complacency come as the area inside the walls became more densely crowded, and the situation became increasingly untenable. This prompted a change in the city council's approach, so that by the early sixteenth century the street level of Krakow had stabilized and the muck stopped accumulating in the streets.[22]

The remainder of this chapter is organized into three parts: roadways, water systems and civic waste management, to show how these essential elements of the city infrastructure evolved. I have organized the contents in this way for the sake of convenience in order to make changes over time more evident. However, I do not wish this approach to obscure the fact that each part functioned as a piece in an integrated system. Infrastructure is the body of a city, roadways and markets are its bones, buildings are its muscles, water is its life's blood, and gutters its urinary tract, while the residents inhabiting this corporeal shell are its synapses and in a greater sense its soul. Medieval people could conceive of the city in terms of a macrocosm of the human body, with each part operating to the benefit of the whole.[23] The civic authorities of Krakow sought to build the body of their city to enhance that soul.

[22] Piekalski, *Prague, Wrocław and Krakow*, 152.
[23] For further reflection on the human body as a metaphor for the city, the body politic, and as a reflection of Christ's body see: Keith D. Lilley, *City and Cosmos: The Medieval World in Urban Form* (London: Reaktion Books, 2009).

The Roadways

Within an urban environment, paved roads were incredibly useful. Bodies and objects could be moved through the city with more ease and in greater comfort which meant a larger volume of trade could be conducted in the city per day. Graded roadways and gutters also helped channel water away from housing foundations where it might otherwise do damage, but most importantly paved roadways meant a cleaner city. Prior to being paved, streets quickly became covered in the detritus of human occupation; broken pots, animal droppings, building debris, and dirt could quickly lead to the first floors of buildings becoming cellars. Krakow was certainly not immune to this effect and between the twelfth and sixteenth century, the city's ground level rose by 4.5 m in some places.[24] Paved streets could be swept clear more easily and helped keep the ground level from rising. They also crucially prevented otherwise serviceable dirt roads from turning into muddy washes after every spring shower. From the thirteenth century, paved streets became increasingly a sign of prestige and the mark of a truly "noble" city as the sources quoted in the introduction demonstrate.[25] The investment required to surface an entire city could be huge, however, and the very expense of it meant that only the "best" cities had paved streets.[26] As a point of pride then, the governing powers of Krakow

[24] Piekalski, *Prague, Wrocław and Krakow*, 138.

[25] In some places paving began even much earlier: Russian cities began surfacing their roads in wood from the tenth century and the Italians in stone by the early thirteenth, all in an effort to cut down on the mess. In 1211, Bologna was among the first Italian cities to put in paving while by 1262, the government of Siena issued an order to pave even the alleyways of the city because those which had been left undone were "spilling filth and mud into the thoroughfares which were already (paved)." David Nicholas, *The Later Medieval City: 1300-1500* (New York: Routledge, 2014), 335; E. Armstrong. "The Sienese Statutes of 1262," *The English Historical Review* 15 (1900): 1–19. http://www.jstor.org/stable/548408; G. M. Scherbo,"Wooden Pavements of Moscow (XI-XIX centuries)," *History and Technology* 8, no. 2 (1992): 111; Mark Brisbane, *Novgorod: The Archaeology of a Russian Medieval City and its Hinterland*, (London: The British Museum, 2001)

[26] Krakow, was lucky in that it had relatively easy access to good building stone and so had a leg up on many other towns where stone was not so readily available. For cities which had less access to a good local quarry costs could be truly enormous. The great craft cities of the Low Countries suffered immensely from this problem so that; for example, the city of Bruges between 1332 and 1398 employed fifteen contractors who "shared the work of paving Bruges's streets at a cost of nearly 12,000 pounds par," while Ghent spent on average 5%-25% of the municipal budget on paving yearly during the fifteenth century. James M Murray, *Bruges, Cradle of Capitalism 1280-1390* (Cambridge: Cambridge University Press, 2005), 59. Nicholas, *The Later Medieval City: 1300-1500* (New York: Longman, 1997), 334.

faced growing social pressure to surface their streets the city and see them kept clean, thereby enhancing the city's reputation.

Figure 2. Cobblestones of the Rynek
(Piekalski, Prague, Wrocław and Krakow: Public and Private Space at the Time of the Medieval Transition, 150)

The first archeological evidence for roadways in Krakow that were more than packed dirt has been dated to the mid-thirteenth century.[27] Upon the city's incorporation in 1257, an entirely new street grid and housing plot plan was laid out. The outline of the new city was designed as

[27]These streets were made of limestone gravel which was spread over the marketplace of the pre-incorporation settlement of Okol. Limestone forms the basis of much of the bedrock in the area around Krakow. The stone was used for building throughout the period and was especially prominent in city works projects after the 1380's when the city purchased the rights to a nearby quarry in the Krzemonski Hills. Piekalski, *Prague, Wrocław and Krakow*, 148, 152. Carter, *Trade and Urban Development in Poland*, 67.

closely as possible to be a central square surrounded by nine rectilinear block districts, given the topography and presence of already existing churches.[28]

These new streets were not immediately paved however, as other more pressing infrastructural projects were tackled first, namely the city walls. In medieval cities, defensive structures always came before street paving.[29] Only once the city's safety was assured, could attention be put on improving its roadways. Fearing a return of Mongol invaders, the first earth and timber works were underway by 1285, with stone construction following by 1298.[30] Soon after, in 1300, the *Rynek* (central market square) and the roadway entering the vital Northern Florinska gate were both paved with dressed limestone cobbles (Fig. 2).[31] In order to cut costs, cash strapped municipalities often sought to spread the burden by first requiring their citizens to pave the length of the area where their property touched the public street. However, problems of uneven workmanship and noncompliance encouraged cities to move on from this approach as soon as they were financially able to do so. This was also the case in Krakow and initially the city appears to have had a mixed system where the most important sites were paved

[28] The razing of the pre-incorporation city of Krakow by the Mongols in 1241 made the subsequent laying out of the new town much easier. Piekalski, *Prague, Wrocław and Krakow*, 64.

[29] An example of this would be English town records showing towns applying first for "murage" the right to collect taxes on goods coming through the city in order to fund the building of a town wall, before they asked for "pavage" the same right to tax in order to pave their streets. Colin Platt, *Medieval England: A Social History and Archaeology from the Conquest to 1600 AD* (London: Routledge, 1978). French examples show the same trend. Evidence from other parts of the continent are also consistent, André Chédeville and Georges Duby, *Histoire de la France urbaine: La ville médiévale,* vol 2 (Paris: Seuil, 1980), 572 Florence was first walled in 1073, Bruges in 1090 nut these cities were not paved until 2-3 hundred years later. Nicholas, *The Growth of the Medieval City: From Late Antiquity to the Early Fourteenth Century* (New York: Longman, 1997), 92-95.

[30] A fear which was entirely justified as the Mongols under Nogay and Telebuga Khan returned and besieged the city in 1287 but thanks no doubt in no little part to the new fortifications were effectively repulsed. Duke Leszek the Black (1279-1288) was the first to grant permission to the town to build fortifications in 1285. Jan Dlugosz, *The Annals of Jan Dlugosz.* Trans. Maurice Michael. (Charlton: IM Publications, 1997), 230. The Wawel hill had its own defensive walls from an earlier period which remained unconnected to those of the incorporated town. Józef Muczkowski. "Dawne Warownie Krakowskie," [The Defenses of Krakow], *Rocznik Krakowski.* 5, no. 13 (1911): 49-110, accessed on April 23, 2016. http://www.zwoje-scrolls.com/zwoje41/text15p.htm. Piekalski contends that the stone walls were not begun until 1300 at the order of King Wenceslaus II (1300-1305), Dabrowski however, cites a Czech chronicle, *Rocznik Świętokrzyski* (Book of the Holy Cross) which says, "Bohem et Cracovia muraverunt et alias municiones in Polonia" (1298) and argues that Wenceslaus II merely continued these efforts. For recent archeological work see: Piekalski, *Prague, Wrocław and Krakow*, 67.

[31] Portions of the central market square were also paved with wooden boards at this date. For a very detailed description of the various types of road surfaces used in Krakow see Piekalski, *Prague, Wrocław and Krakow*, 148–51.

professionally at the city's expense while in other areas citizens were responsible for paving the road themselves. During the late fourteenth century however, the city took on full responsibility for all main streets, as the appearance of pavement expenses in the municipal accounts and the regularity of the workmanship shows. [32]

Given the expense involved, it made sense that the first sites in the city to be paved were those most important both for their prestige value and their importance to trade thus the main market, the cattle market, and streets leading to major gates.[33] Soon, paving soon expanded to other parts of the city after Krakow had acquired the rights to a limestone quarry in the nearby Krzemonski Hills in the 1380s.[34] A *magister pavimentorum* was put in charge of the efforts and as the municipal account records show, considerable funds were expended by the city to improve its roadways and bridges.[35] These new roadways were built of wedge-shaped limestone blocks set into a sub-base of sand designed to improve drainage and graded towards the center of the street to channel water away from the houses on either side.[36] Down the middle of the street ran a deep central gutter which was covered over with wooden-plank

[32] The first street cleaning statute was issued in 1373, but while archeological evidence of paved streets appears long before this, payments made by professional *paivors* do not come up in the municipal budget until 1390. Thus it appears likely that during the earlier period, citizens were required to do the work themselves or hire a professional to do it for them. Soon after the 1373 law was issued, however, an addendum was added stating that should any individual have paved the area in front of their property twice over, then it was the city's responsibility to step in to do so thereafter. However, in 1384, the city fathers likely having found this benevolence too expensive, a further addendum split the difference where the city agreed to be responsible for providing stone and sand as paving materials while the citizen would pay for the labor costs. The timeline for these changes falls neatly into line with the city's acquisition of the Krzemonski limestone quarries which would have provided a cheap source of paving stone. This means, that by 1390, when the first professional *paivors* appear, being paid out of the municipal budget, the city could afford to hire them directly rather than requiring citizens to do so. Evidently, the lower, associated material costs had made more room in the budget. For the dates of *paivors* in the municipal budget see: Niemiec, "Bruki na placach…,277. For the original text of the 1373 and 1384 statutes see: Estreicher, *Najstarszy zbiór przywilejów…,* 23, no. 4.

[33] Niemiec, "Bruki na placach i ulicach," 284-85.

[34] Carter, *Trade and Urban Development in Poland*, 67.

[35] Expenses related particularly to street paving appear on the city's books in 1390, 1395, and 1397. Niemiec, "Bruki na placach i ulicach," 277. Bridges were built across the Rudawa and the moat once it was constructed only later as well as in time, the Vistula. These constructions built of oak timber and stone were much more costly than simple paving. Kutrzeba, *Finanse Krakowa w wiekach średnich*, 92.

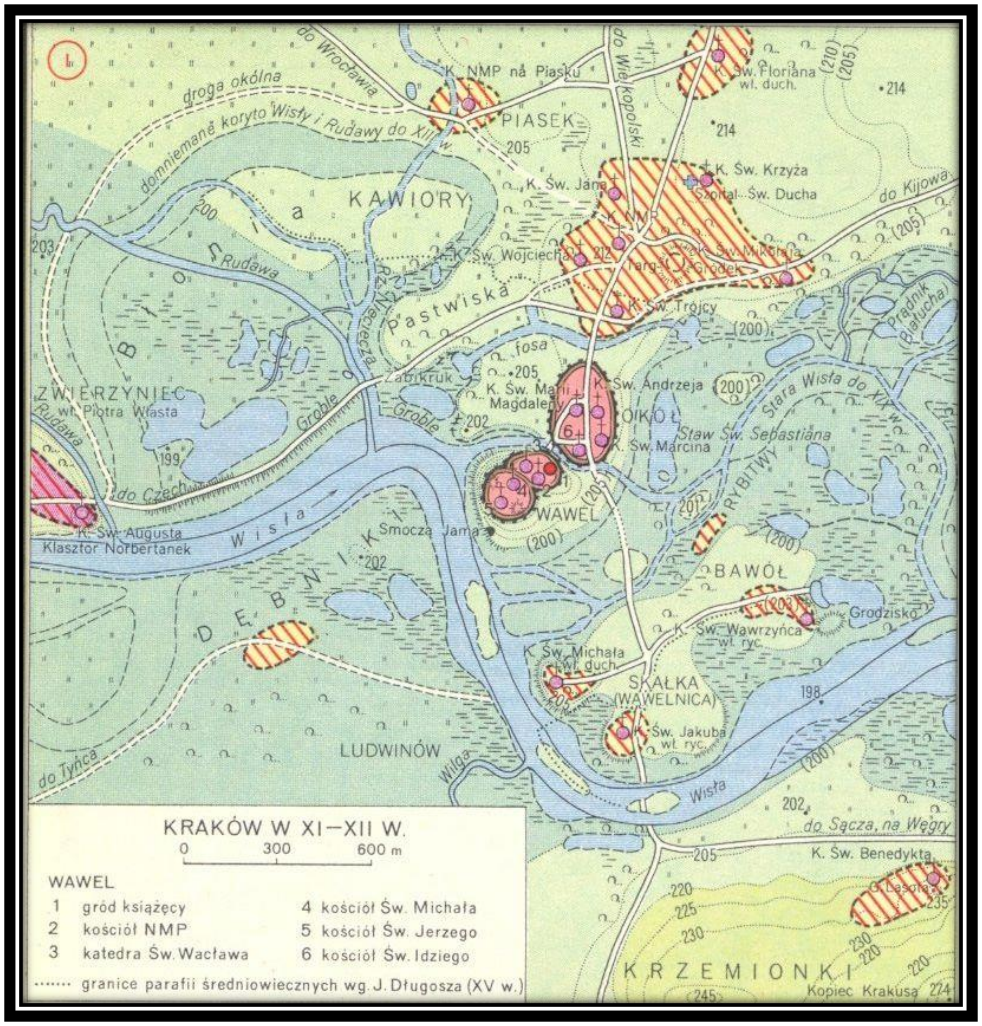
[36] Piekalski, *Prague, Wrocław and Krakow*, 151.

brucken (bridges), every few meters allowing pedestrians to cross.[37] These *brucken* appear to have been very important for communication within the city. They can be seen in a contemporary image from the Behem codex and have also been unearthed by archeologists from the central market square.[38] (Fig. 3) By the second half of the fourteenth century nearly all of Krakow had been paved in some form.

Figure 3: Bruken covering the gutter in a Krakow street
(Detail from the Behem Codex Guild of the Kowale I Konowaly (the Blacksmiths and the Farriers) Folio 297)

[37] Płaśnik, Jan. "Towns in Medieval Polan," in *Polish Civilization: Essays and Studies*, ed. Mieczyslaw Giergielewicz and Ludwik Krzyzanowski (New York: New York University Press, 1979), 29.
[38] Estreicher, *Najstarszy zbiór*, 23, nr. 4.

The Waters



The most impressive part of medieval Krakow's civic infrastructure was undoubtedly its water system. By the fourteenth century the city had a comprehensive system to provide fresh water and a second set of gutters to deal with waste waters and storm surge. This achievement is particularly noteworthy as while Krakow may appear to be a water-rich site because it was founded on the high bank of a river~~,~~ in reality, it suffered from a scarcity of this precious

resource.[39] (Fig 4) The defensive fortifications built in the wake of the Mongol invasions of the thirteenth century, only compounded the problem as it cut its residents off from easy access

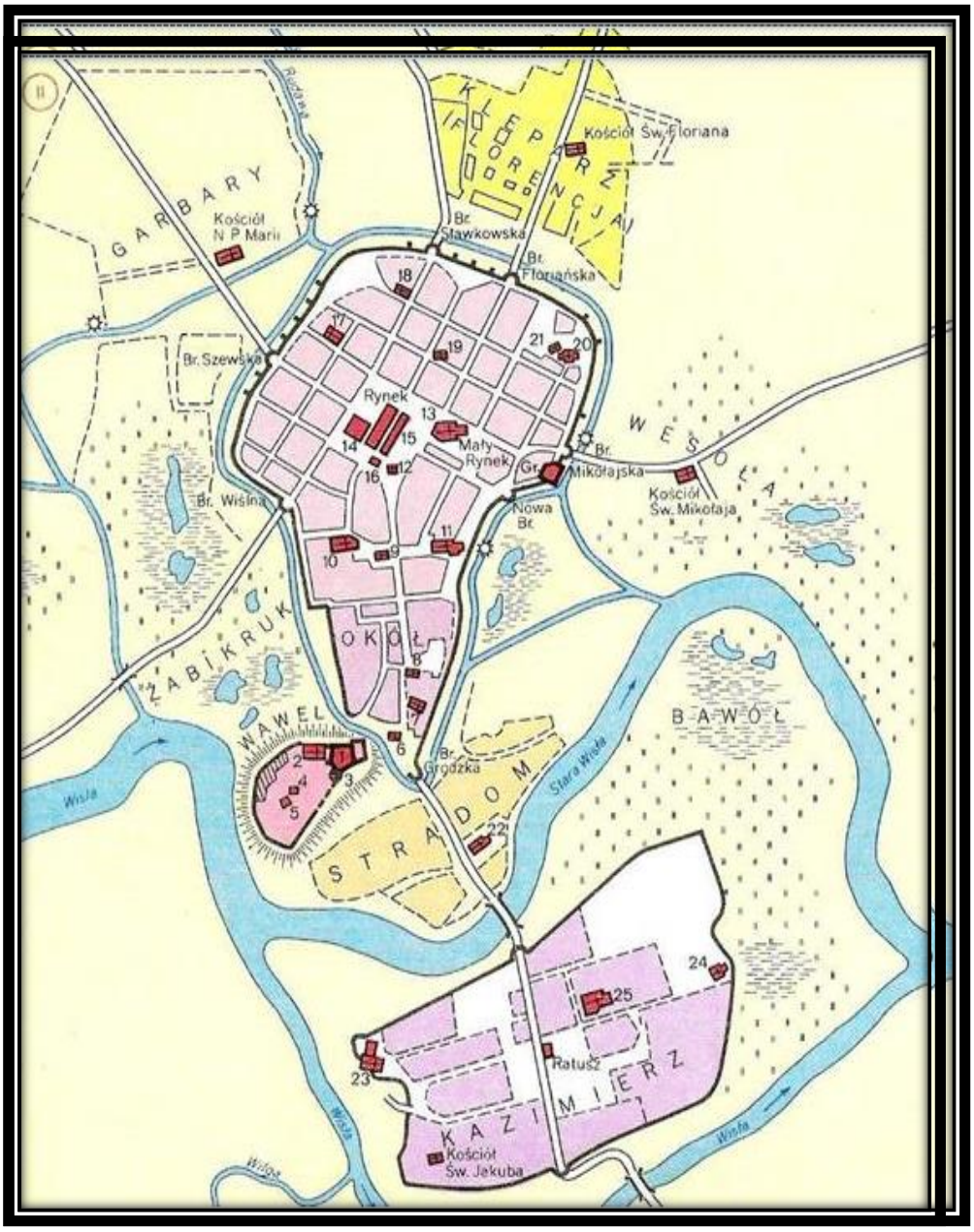


Figure 5: The Water Systems of Krakow after the Fourteenth Century (Carter, Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 1795, 66)

to local waterways.

[39]This off-shoot of the Rudawa came to be known as the Młynóska Norbertanska and was dug between 1285-6. Digital Display "Water Supply and Sewage Systems in Medieval Krakow", *Muzeum Historyczne Miasta Krakowa*, Krakow, Poland Accessed January, 25, 2016. Urszula Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," *Fasciculi Archaeologiae Historicae* 24 (2011): 11.

A way to bring water into the heart of the city became a paramount concern that over the centuries would be tackled in increasingly sophisticated ways.

The first major water project initiated by the city came very soon after its incorporation in the 1280s and was defensive in nature. The~~. The~~ residents of Krakow dug a deep trench around the outside of the city's fortifications tapping the nearby Rudawa River where it swung close to the Northwestern edge of the city not far from the Sławkowska gate (Fig 5).[40] Improved over the centuries, the waters made their circuit and then flowed through two possible outlet points, one not far from the Grodzka gate and another sweeping out from near the New gate behind St. Nicholas's church, both eventually joining the Vistula. The proper circulation of the moat waters was important as it kept them from becoming stagnant and swept waste which was dumped into it away from the urban environment. This new moat thus served many functions: it stood as a strong defensive barrier, a spill point for the city's drainage system, and in time would also provide the intake point for the city's piped fresh water supply which was purposefully located upstream of the waste water outlets. The city moat was intimately connected to both the city's fresh and waste water systems.

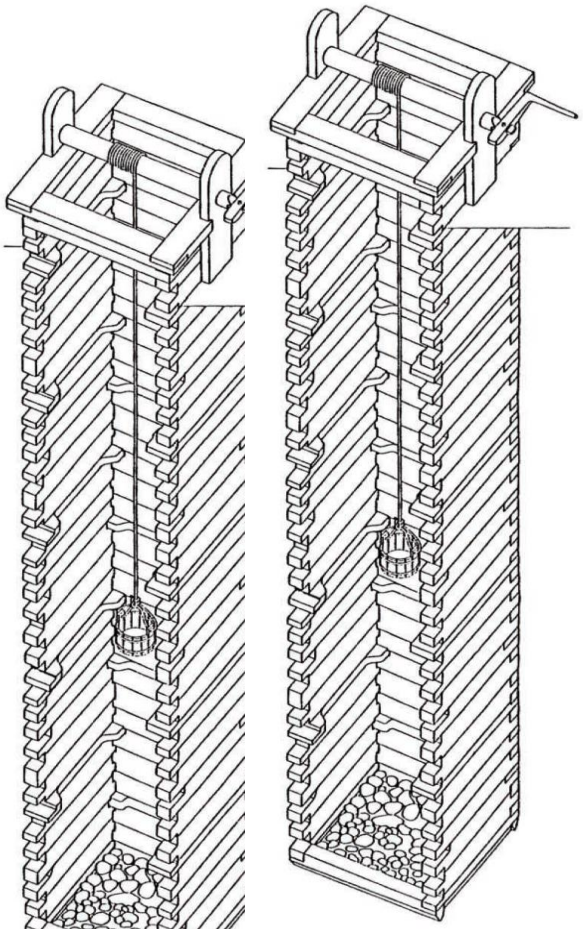
The Fresh Water Supply

By the end of the fourteenth century, Krakow residents could get their fresh water from three sources; drawing it from the river, from local wells, or from a new piped water system known as the *rumurs.* Of the rivers surrounding Krakow, the Vistula was key for trade~~;~~ and communication but far more important for daily life was the Rudawa, a smaller more easily controlled tributary which ran closer to the settlement itself.[41] Water from this river might be

[40] Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," 11–12.
[41] The Vistula was also kept free of water-wheels as these would have interfered with passing shipping traffic and thus mills were sited along the Rudawa.

drawn by local residents or brought to one's home carried by professional water-bearers.[42] After the city was surrounded by its walls however, the Rudawa and its moat were literally bricked off and so access became difficult. [43] The solution to the problem until the fifteenth century was the building of public and private wells.

~~Private Wells~~ Private Wells



~~rank Well reconstruction~~
~~zynski, 2011 28)~~

~~rank Well reconstruction~~
~~zynski, 2011 28)~~

~~rank Well reconstruction~~

Figure 6: Hand-Crank Well reconstruction
(Cembrzynski, Zaopatrzenie w wode i usuwanie nieczystości w miastach stref bałtyckiej i sudecko-karpackiej w XIII-XVI wieku / Water Supply and Waste Disposal in Cities of the Baltic and Sudeten-Carpathians Zones in the 13th-16th Centuries, 28)

~~(Cembrzynski, 2011 28)~~

[42] In 1399 the city accounts record 20 water-bearers making the city rounds who by this time may have been drawing water largely from the city wells and rather than the river. Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," 15.

[43] This was particularly true should one need water by night. The city gates were shut every evening and could be opened only with the express consent of the mayor and the city council between sunrise and sunset. Not even high members of the nobility were permitted to force the city gates open after they were shut for the night; no one was going to be allowed to compromise the city's security simply to drag in a bucket of water. See Jan Płaśnik "Towns in Medieval Poland," in *Polish Civilization: Essays and Studies, ed.* Mieczyslaw Giergielewicz, and Ludwik Krzyzanowski (New York: New York University Press, 1979), 25–27.

Private wells appear to have been a fixture of medieval Krakow. Multiple images from the Behem codex show people using wells located in the public street and in private craft shop

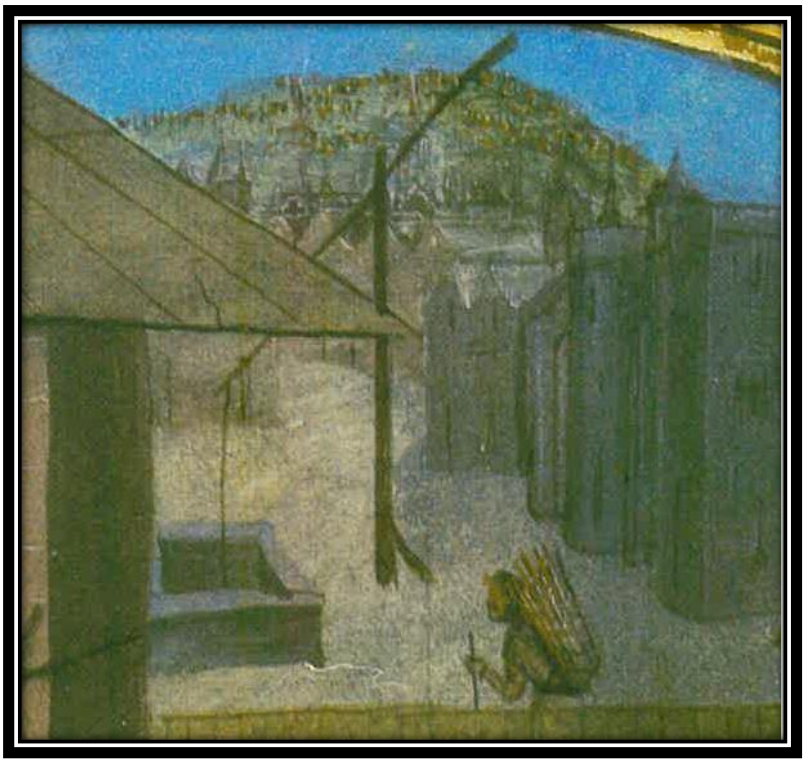


Figure 7 A public lever style well
Detail from the Balthzar Behem Codex Garncarze (Potters Guild) Folio 272

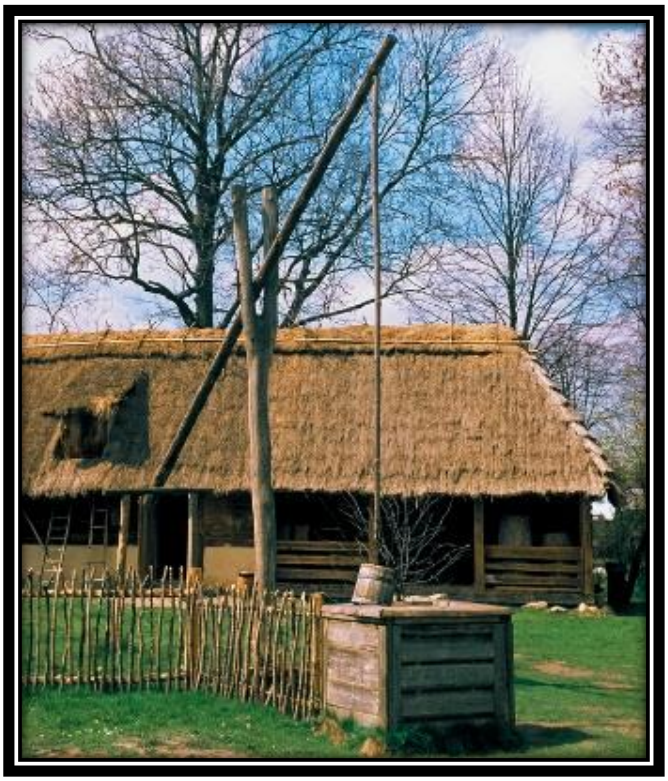


Figure 8 Preserved Lever style Well
http://www.wodociagi-polskie.pl/dzieje-wodoci%C4%85g%C3%B3w/xvii-xviii-w/ (photo Dariusz Zaród Photoagency.com.pl)

courtyards (Fig. 7).[44] These wells were usually located towards the front of the back-lot of the

property, set some distance from the latrines and cesspits sunk towards the rear in an effort to ~~in an effort to~~ avoid the water being contaminated~~contaminated~~ with sewage. [45] In another bid to prevent contamination, wells constructed in Poland were generally lined with wood and the recycling of old barrels for use as well shafts has been seen in archeological finds in Krakow (Fig.6). [46] Such barrels, originally designed to be water-tight, were prefect for the purpose and, "could provide, along with sand filters, protection of drinking water from external contaminants. On occasion such wells served as settling tanks which could allow accumulated sand and silt to be easily removed." [47] Some lined wells were then further insulated with a layer of clean sand, clay, or charcoal to act as a further layer of protective filtration.[48] This method of insulating wells from impurities, practiced since Roman times and recommended by both Vitruvius and Pliny the Elder, continued in Poland throughout the medieval period.[49] The care

[45] "For more on latrine and well locations in Krakow plots see: Piekalski, *Prague, Wrocław and Krakow*, 88.
[46] For an exhaustive study on the construction of both wells and latrines in parts of medieval Poland see: Cembrzyński, *Zaopatrsenie w wode* , 35.
[47] Cembrzyński, *Zaopatrzenie w wode ...,*50.
[48] Methods which are used in modern filtrations systems today. Wells excavated in Wraclow, Opole, and Głogów showed these features and it appears likely that further excavations carried out in Krakow will reveal similar finds. Cembrzyński, *Zaopatrzenie w wode…, 34.*
[49] Vitruvius recommends, "If these receptacles [basins] are made in two or three divisions, so that the water may be passed from one to another, it will be more wholesome for use; for the mud in it will be thus allowed to subside, and the water will be clearer, preserve its flavour, and be free from smell; otherwise it will be necessary to use salt for purifying it." Vitruvius Pollio, *Vitruvius: The Ten Books on Architecture,* trans. M. H. Morgan (New York: Dover Publications, 1960.) 8.6.15; Pliny the Elder, "The best plan, too is to have the cisterns double so that all impurities may settle in the first cistern, and the water filter through, as pure as possible into the second one." Pliny the Elder *Natural History*, trans. H. Rackham (Cambridge, ma: Harvard University Press, 1938), Book 36, Section 173.

with which these wells were constructed demonstrates that residents were aware of the dangers of water contamination and sought through multiple means to protect their water's purity.

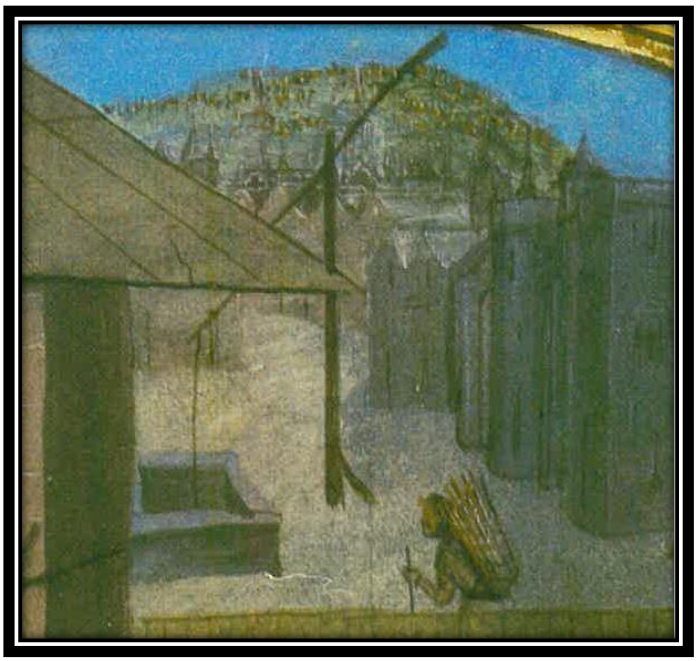


Figure 4: A public lever style well
(Detail from the Balthasar Behem Codex Garncarze (Potters Guild) Folio

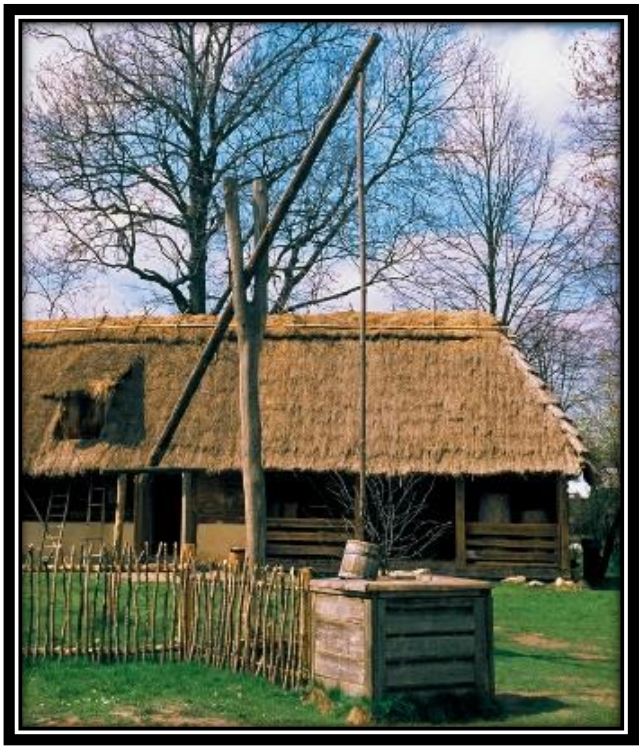


Figure 8 Preserved Lever style Well
http://www.wodociagi-polskie.pl/dzieje-wodoci%C4%85g%C3%B3w/xvii-xviii-w/ (photo Dariusz Zaród Photoagency.com.pl)

Public Wells

Figure 9: Preserved Polish hand-crank style well
(From the open air museum in Sanok http://www.wodociagi-polskie.pl Dariusz Zaród Photoagency.com.pl)

Not everyone could afford to sink their own well and so the city stepped in to help provide free public water to its citizenry. By the fourteenth century, Krakow had between 25 to 30 public wells distributed across the city with many concentrated in the market squares.[50] These public wells were dug deeply and the water raised either by means of a hand crank or lever shaft (Fig. 9).[51] The positive social function of these sites inspired elites to patronize the instillation of a well, donating its use to the public at large as a means of demonstrating their largess and increasing their prestige. Indeed, a number of wells in the central market square were known by the family names of the prominent burghers, whose houses were built nearby.[52] Other wells were funded directly by the city which records show spent a great deal on their

[50] Sowina, "Water Supply…,13.
[51]Cembrzyński, *Zaopatrzenie w wode…,* 35 .
[52] Sowina, "Water Supply…,13. Antonina Jelicz, *Życie codzienne w średniowiecznym Krakowie: wiek XIII-XV* [*Everyday life in mendieval Krakow: XIII-XV*] (Warsaw: Państwowy Instytut Wydawniczy, 1966), 69.

upkeep, showing that the management of water was obviously of prime importance to the city council.[53] By the fourteenth century, Krakow had a good system of well-maintained free public wells paid for by generous members of the community and from the civic purse. Towards the end of the century, however, this system was deemed insufficient. As. As the population rose, more water was needed, and the combined number of latrines built began to constitute a risk to the water supply. As Krakow bloomed during the period both demographically and economically, a new system of piped water was designed and built to meet demand. [54]

[53]Funds spent on wells appear sporadically throughout the record, implying sudden repair needs or the decision to build a new well rather than constant steady stream of maintenance funds. The monies spent at these times were considerable. Kutrzeba, *Finanse Krakowa w wiekach średnich, 93.*

[54] "Water was brought to the Jewish bath at St. Anne's, whose outlet was on St. Anne street. The water supply could, therefore, run down to the Market on St. John street and Sławkowska street toward the gate at St. Anna alley located within the walls. It is possible, that the water supply was also along Szewskiej street. Already in the middle of the fifteenth century, pipe was laid on Sienna and Stolarskiej streets, where it supplied the Dominican monastery and had reached the main market where there was a public water-conduitsconduit. This was what we have been able to reconstruct on the basis of references in written sources for the fifteenth century, but it is certainly possible that other pipelines existed that have not come to light in the records….In the sixteenth century, the network probably covered the entire city. In the sixteenth and the first half of the seventeenth century, the main market had 4 water conduits." Cembrzyński, *Zaopatrzenie w wode…,*56.

The rurmus System

Figure 10: Model of the Krakow rurmus
Temporary Exhibit Muzeum Historyczne Miasta Krakowa.
(Photo from: http://polandsite.proboards.com/thread/1966?page=1)

Krakow's need for an expanded water system came just as a new age was dawning in hydraulic technology, based on innovations made in mining machinery in the German lands.[55] Many of these innovations were in time transferred to cities where the increasingly wealthy mine-owners made their homes. The first evidence for the inauguration of a piped water system in Krakow comes from 1385 when the city records report that Piotre Swalme was named *rurmistrez* i.e. *rormagister* (pipe master).[56] This put Krakow well ahead of many other cities

[55] For the culmination of medieval water pump technology see the illustrated work *De re metallica* by the Saxon Humanist Georgius Agricola published in 1556. Georg Agricola, *De re metallica*, trans. Herbert Hoover and Lou Henry Hoover (New York: Dover Publications, 1950).

[56] These pipe-masters were in charge of designing, building, installing, and managing the city's new pipe system. They drilled the logs, got others to make the iron fastenings needed to latch them together, oversaw work crews to dig trenches to bury the pipes deeply enough so that they would not freeze in winter at a depth of 2 ells (120 cm), and managed new hook-ups. The position was paid for by the city council. ~~City Council.~~ Digital Display "Water Supply and Sewage Systems in Medieval Krakow".

including Bremen which produced its first water tower in 1400 and Nuremburg which did not have one until 1483.[57]

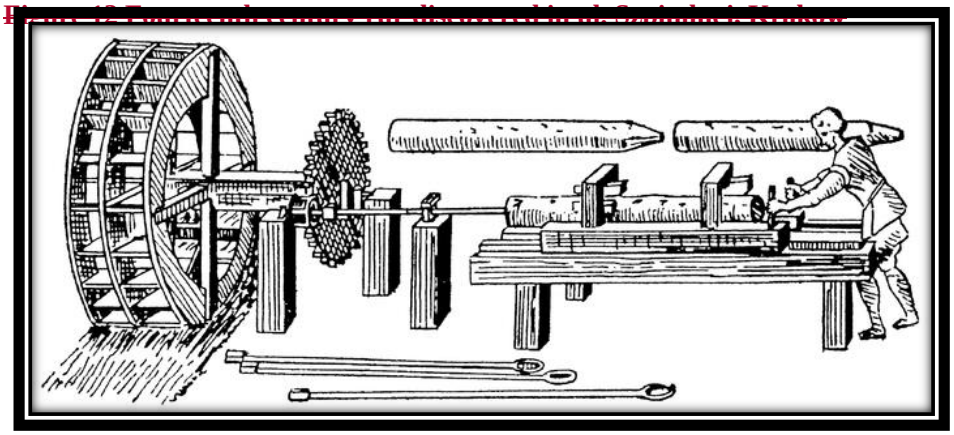
Figure 11: Fourteenth Century *Rur* Designed with Split and Pitch Method
Discovered in ul. Szpitalnej, Krakow
(http://wodociagi.krakow.pl/historia.html)
~~WODOCI%C4%85G%C3%B3W/RENESANS/~~

The Krakow *rurmus* (water tower) (Fig. 10), which produced the pressure to run water through *rurs* (split and pitched or later on drilled wooden logs linked together with iron fastenings), (Fig. 11/12) was located just outside of the city walls at the site where the Rudawa River had been tapped to fill the city moat.[58] In order to build up enough pressure to run the system, a water wheel powered by the river's current was attached to a shaft and belt system which conveyed buckets of water up to the top of the water tower producing the pressure needed to

[57] Krakow was ahead of many cities, including Wroclaw which built its first water tower a year later in 1386, but all of these were far behind the first recorded municipal *rurmus* (water tower) which appeared in Lubeck in 1293. Urszula Sowina, "L'eau et les nouveautés techniques dans l'espace urbain et suburbain au Moyen Age" [Water and technical innovations in urban and suburban space in the Middle Ages], *Actes des congrès de la Société d'archéologie médiévale* 6, no. 1 (1998): 82.

[58] The *rur* pipe technology advanced over the centuries. In the beginning, logs were split into two pieces, the bottom half would be scooped out to form a trough where the water could flow and then the top half would be set back on top and sealed with pitch and moss. This method worked well for a simple gravity powered system but could not handle a higher amount of pressure. As the *rurmus* became more powerful, a new system for drilling a hole clean through the logs and tapering the ends so that they might be jammed together to make a tighter seal was devised so that greater water pressure could be accommodated. In other cities, ceramic pipes and even lead ones were used. For more see: Cembrzyński, *Zaopatrzenie w wode…,45*.

force water through the pipes. Very importantly, from a waste management perspective, this water tower was located upstream of the city and the industrial activities carried out near the Debowa Tanner's mill in the suburb of Garbary, thus lowering the risk of contamination by either sewage or industrial bi-products (Fig. 16)[59]. The intake point was also further protected by a primitive set of filters called *miotła* (broom) and *grezbień* (comb).[60] Moreover, the city's two main sewage gutters emptied into the Rudawa filled moat well downstream of the freshwater intake point, which~~,~~ given the city's topography~~,~~ need not have been the case. This~~.~~ ~~This~~ likely demonstrates ~~demonst~~forethought to prevent contamination of the freshwater supply.



For the first forty years of the project then, pipes were laid in order to supply only public conduits and craft sites, not private homes. By the time Master Marcin was stepping into his

Figure 12: Drilling of a *rur* (wooden-pipe) " 1615
(ww.wodociagi-polskie.pl)

role as pipe-master in 1436, the city had become dotted with *rząmpia* (water conduit), large wooden boxes from which a metal spigot sprung and fresh water could be drawn (Fig. 13/14).

[59] For the location of the Tanner's mill see: Bieniarzówna, *Dzieje Krakowa*, vol. 1, 344–45.
[60] Sowina, in her work drew the conclusion that *rurmurs* were often sited without consideration for contaminants that might be introduced upstream as people believed in the "purifying power of rivers". I strongly disagree with this assessment. Sowina, "Water Supply…",13–14.

These new conduits expanded upon the old public well system providing fresh water to the common populace and also supplied the breweries and the public baths. To pay for all these

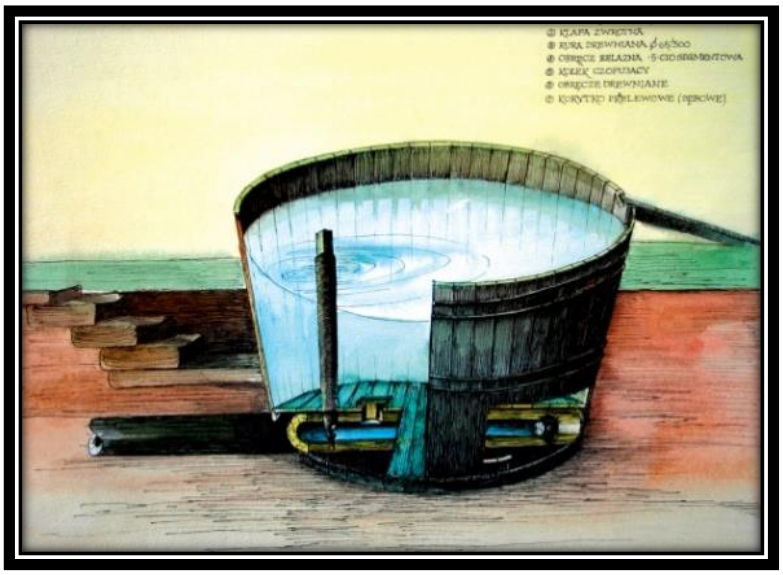


Figure 13: *Rzampia* Water Conduit Design Reconstruction
(http://www.wodociagi-polskie.pl/dzieje-

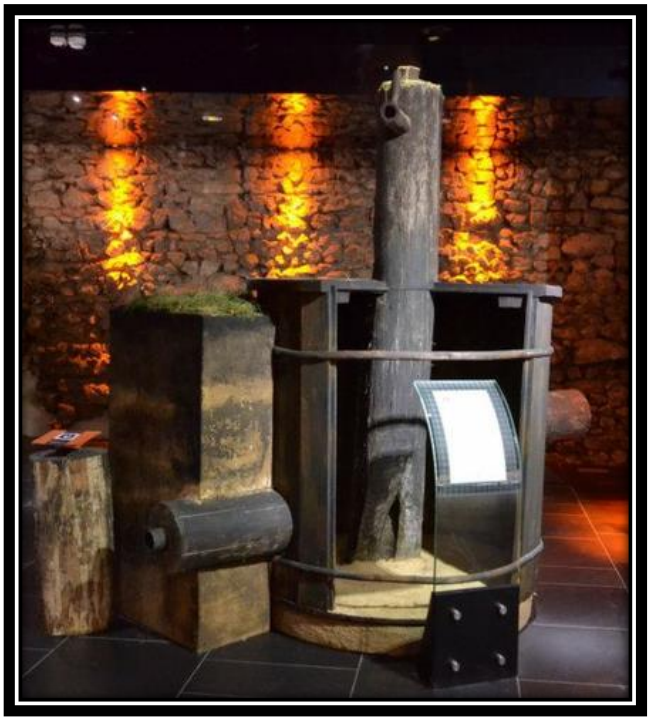
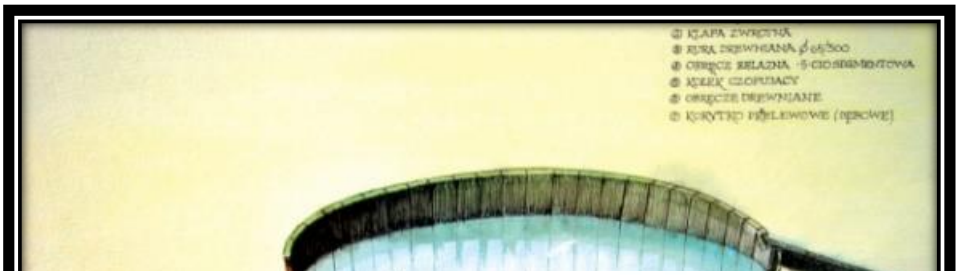
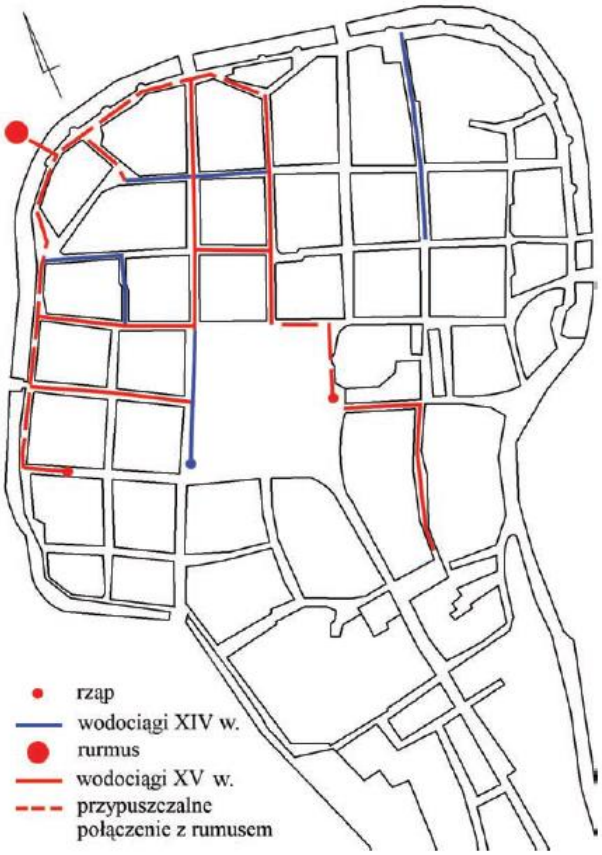


Figure 14: Preserved Krakow *Rzampia* Water Conduit
Muzeum Historyczne Miasta Krakowa (Photo by the author)





Ryc. 35. Sieć wodociągowa Krakowa w XIV–XV w. (Ligęza 1971, tabl. I, z uzupełnieniami na podstawie Sowina 2009)

Figure 14 Preserved Krakow *Rzampia* Water Conduit
Muzeum Historyczne Miasta Krakowa (Photo by the author)

new amenities, around 1453 the city council began levying a tax on every household known as the *rorne* (pipe tax) which charged everyone for water usage independent of whether you were

hooked up to the system or not.[61] This *rorne* tax brought a great deal of money into the public coffers.

Figure 15: Proposed pipe lines in Krakow during the fourteenth and fifteenth centuries
(Cembrzyński, Zaopatrzenie w wode i usuwanie nieczystości w miastach stref bałtyckiej i sudecko-karpackiej w XIII-XVI wieku / Water Supply and Waste Disposal in Cities of the Baltic and Sudeten-Carpathians Zones in the 13th-16th Centuries, 56)

[61] Households which had private wells were charged 1 1/0 grosz while houses without wells, who theoretically took more water from the public conduits, were charged 2 grosz per annum. Kutrzeba, *Finanse Krakowa w wiekach średnich*, 93.

The Waste Water System

Krakow's drainage system began to develop with the building of the city moat in the 1280's and continued in conjunction with the formation of the city's street grid.[62] As streets were paved, they were designed with gutters running down their center to carry waste water and storm surge away from the houses bordering on either side. Archeological excavation of the central square and the *Rynge* have revealed that these gutters were built 1m wide and up to 2m deep making them formidable channels and thus the wooden *brucken* were installed providing a means to cross [63] City statues show that the upkeep of these roadways and gutters were the combined responsibility of the city and the resident whose house frontage they were closest to.

These public street gutters were not the only system of waste-water flushing that existed in Krakow. Work done by Sowina has also demonstrated that another series of channels were cut through the back plots of some residence to further encourage drainage. [64] These channel's~~channels'~~ main purpose appears to have been to connect households to larger city gutters and were at times open and at others buried underground. They carried primarily waste waters and sewage from individual homes, flushing them out into the central system (Fig. 16). [65] Both the street gutters and back-plot channels flowed away from the main market square at the center of town down towards the city walls following the line of Krakow's topographical

[62]The expansion and deepening of the moat provided a lower point towards which water could flow from the town encouraging drainage and helping to prevent flooding and the retention of sewage water. Another consequence of this, was of course the simultaneous lowering of the fresh water table which meant that wells had to be dug deeper as a result making them more expensive and difficult to drill, but were also likely cleaner. Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," 15.

[63] Digital Display "Water Supply and Sewage Systems in Medieval Krakow".

[64] Urszula Sowina, "Kanały Wód Odpływowych W Późnośredniowiecznym I Wczesnonowożytnym Krakowie" [Channels Water Run-off in the Late Medieval and Early Modern Krakow]. In *Ulica, Plac I Cmentarz W Publicznej Przestrzeni średniowiecznego I Wczesnonowożytnego Miasta Europy Środkowej* [Streets, squares and cemeteries in public space; New research in medieval cities in Central Europe], ed. Stefan Krabath, Jerzy Piekalski, Krzysztof Wachowski, Wratislawa Antiqua 13. (Warsaw: Instytut Archeologii Uniwersytetu Wrocławskiego, 2011), 270.

[65] Sowina shows proof of this by looking at records of conflicts between neighbors when such sewage lines cut across multiple properties and when a new party wished to build their own canal and connect to the network. Sowina, "Kanały wód odpływowych... 270.

elevation. This water was funneled towards two main gutters, one on either side of the city that acted as spill points issuing into the city moat. One gutter ran out next to the New Gate on the city's Eastern side while the other spilled out near the Wisła gate to the West.[66] Also, on the western side of the city beyond the New Gate, the cloth industry added its waste water to the moat and the stream which connected it to the Vistula. All of this waste water entered the moat well downstream of where fresh water was taken into the city pipe system at the North end ~~end~~ of the city. The water flowed southwards~~,~~ picking up the sewage and runoff and mixing with contaminants from ~~contaminantsfrom~~ the tanneries, shambles~~,~~ and bleacheries~~,~~ which marked moat and the Rudawa's banks. Eventually, this murky mix found its way

[66] Sowina, "Kanały wód odpływowych,", 269, 271.

through a stream bed on the west side of the city to the Vistula where it mixed in the current of the greater river, effectively diluting it.

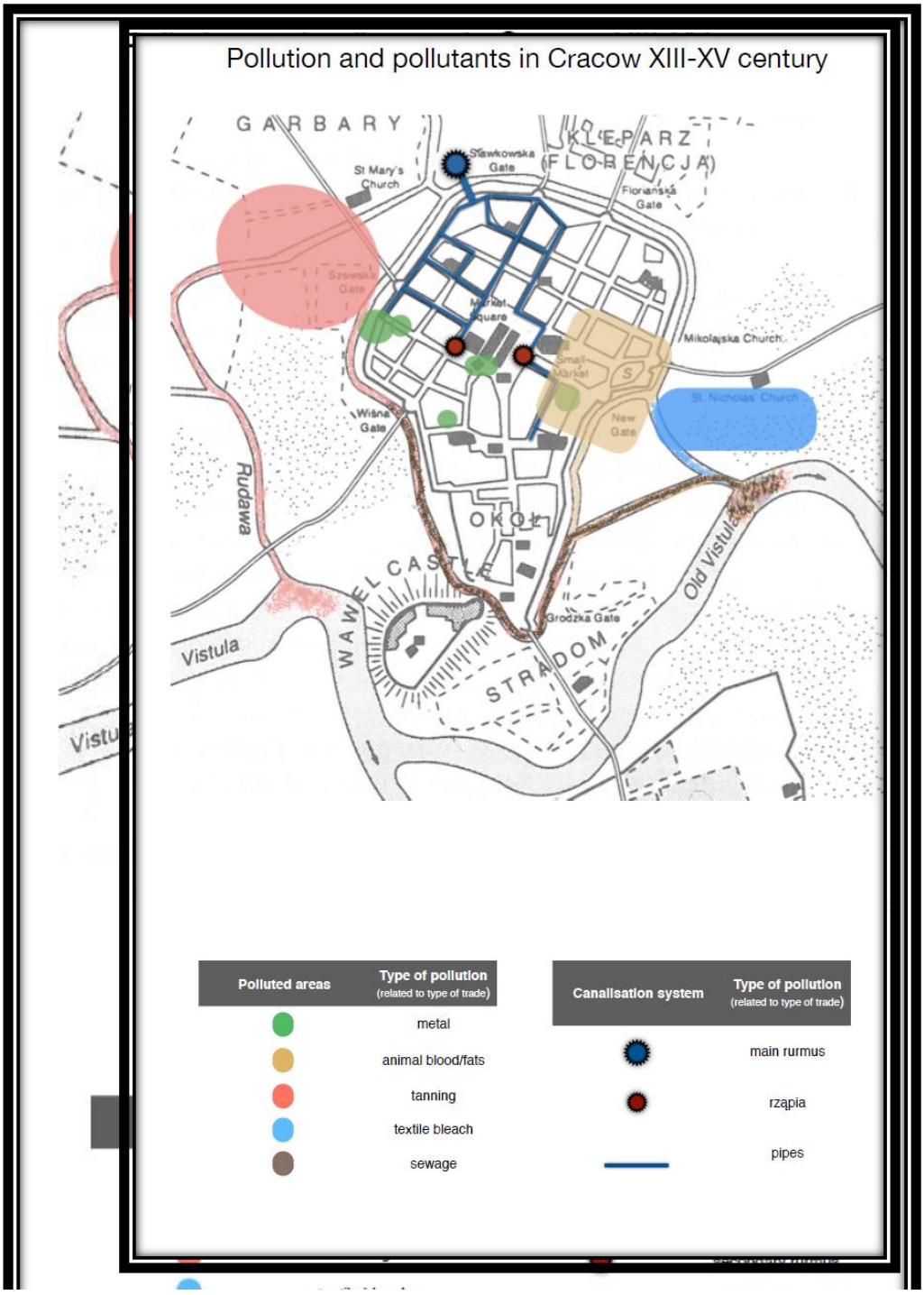


Figure 16: Map showing Krakow's water-pipes with the *Rurmus* set above the major pollution zones

Figu (Map, Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 1795, 66) Markings by the Author and Karol Nowoszynski

Civic Waste Management

The civic authorities of Krakow do not appear to have managed its waste very effectively through the medieval period and the city remained a far dirtier place than its relative neighbors despite having impressive and even superior water and road infrastructure from an early date.[67] The key to this difference is perhaps that other cities developed a more comprehensive plan for waste regulation while Krakow's wastes continued to be managed through a series of somewhat limited ad-hoc legislation, spotty enforcement, and not a coherent agenda. Why was this the case? This question, we will now attempt to answer.

If any "program" for improving city cleanliness can be identified in Krakow, it would be a constant focus on improving the city's infrastructure. As detailed above, Krakow had an impressive fresh and waste water system and by the early fourteenth century nice regular cobblestone streets, well ahead of many other cities at the time. Yet, efforts to keep wastes from overwhelming these areas was hampered by its public nature that was victim to the collective goods dilemma. This conundrum meant that no matter how excellent the initial infrastructure was, it would not be sufficient to ensure a clean city, other measures would have to be adopted in order to keep it from being degraded once it was in place. It was here that the civic authorities failed. From the records, it appears that no plan was ever developed during the medieval period in Krakow to deal with these waste issues. Indeed, prior to the sixteenth century, the records of the city's finances show no sign of central planning or even an annual budget so it is perhaps too much to imagine that they would have had a coordinated public

[67] The city saw its ground level continue to rise into the sixteenth century; standing in stark contrast to both Prague which had wooden planked streets already in the tenth century and its ground level had stabilized by the thirteenth century. While Wrocław, which had paving only in the thirteenth century saw its ground level settle in the mid-fourteenth. The continued rise of Krakow's ground-level into the sixteenth century is even more surprising given that its limestone paving was of a higher grade and easier to clean than the paving of the two others. Piekalski, *Prague, Wrocław and Krakow*, 152.

policy on waste.[68] The city authorities did make some attempts to deal with the problem but their tactics were reactive rather than proactive and overall do not compare favorably with methods adapted by other polities facing similar dilemmas. The nature of these attempts, their disappointing results, and the possible reasons for the city's failure to adopt a better strategy will be explored in the following section.

Road Cleaning Legislation

As discussed in the previous section, by the second half of the fourteenth century nearly all of Krakow would have been paved in some form.[69] The first recorded statute on road cleaning was laid down in 1373. The text of the law ran,

> The members of the town council of this year have ..., given the regulation to be unchangeably in common agreement; that everyone living along any part of the *Rynge* should shovel all rubbish or trash within a distance of 16 ells from his doorsill. The house owner should in the area of 16 ells from his doorsill, shovel the trash up to the gutter, and not less, and he should do so following the custom of the city.[70]

Recorded in the margin of the manuscript was included the fine to be levied for noncompliance.

[71]

[68] Carter, *Trade and Urban Development in Poland*, 26–7. For more detail on Krakow's medieval civic finances see: Stanisław Kutrzeba, *Finanse Krakowa w wiekach średnich.* [Krakow's Finances in the Middle Ages] (Kraków: Drukarnia "Czasu" Fr. Kluczyckiego i Spółki, 1899).

[69] Some streets were paved only in part while some minor roadways were not cobbled until the fifteenth century. Niemiec, "Bruki na placach," 284-85.

[70] The original text, headed in Latin and otherwise written in German as was common for many Krakow statutes at the time runs "Di rotherrin des jaris mit rat vorkentnisse vnd willen der eldstin der stat haben di zaczczung vnwandilberlich czu haldyn in gemeyner eyntrechtikeyt gemacht vnd gesaczt: Daz yczlicher an allen teylin des ryngis alumme gesessin sal sechczen elyn an syner türswelln anczuhebin noch der breyte sines erbis allenthalbin kegin des ryngis gerynne schüfelin den mist vnd allerley vnflatis enyk haldin vnd nicht mynner vnd daz usfüren, noch der stat gewonheit. Added in the margin "Pena vnius fertonis" Estreicher, ed., *Najstarszy Zbiór Przywilejów*, 23, no. 4.

[71] Ibid. The fine was one Ferto, equivalent to: ¼ of a Mark or 12 Bohemian Grosz. *Elektroniczny Słownik Łaciny Średniowiecznej w Polsce (A-Q)* (Medieval Latin Polish Electronic Dictionrary A-Q) s.v. "Ferto," accessed 6 april, 2016, http://scriptores.pl/elexicon/pl/lemma/ferto#sense_II

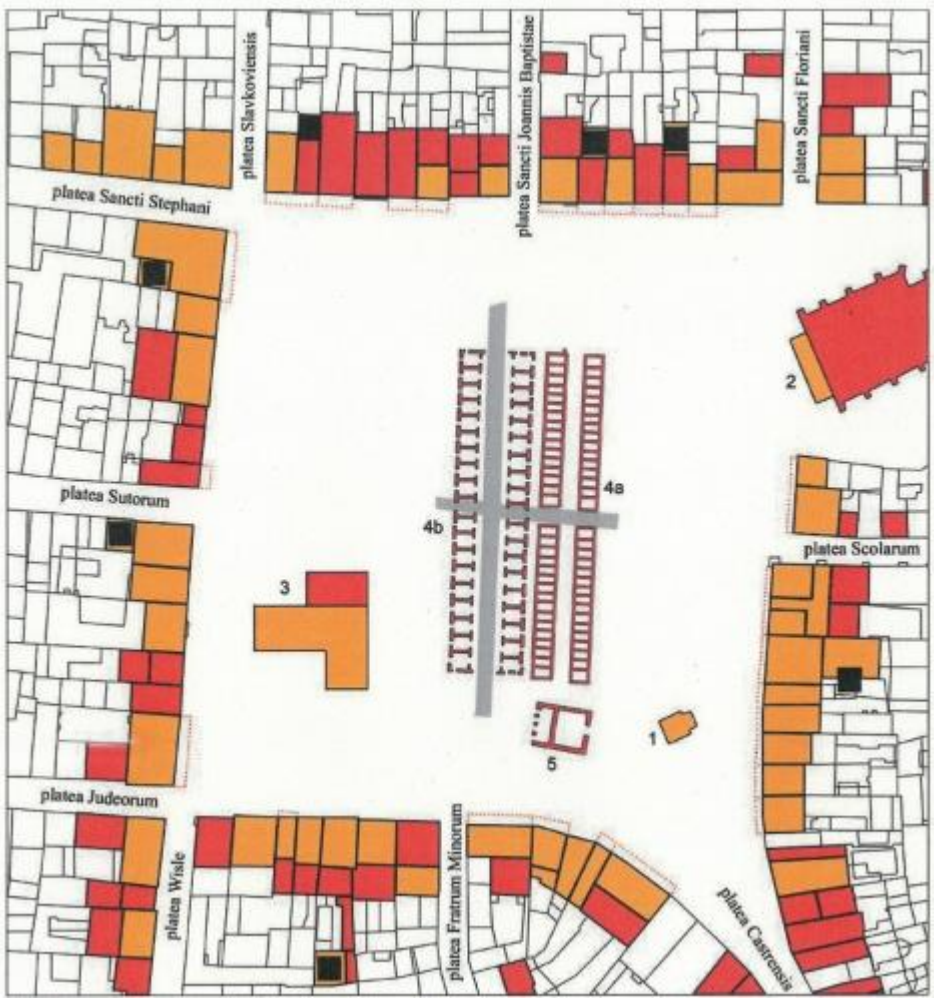


Figure 17: The *Rynge* Surrounding the *Rynek*
(Pieklaski, Prague, Wrocław and Krakow: Public and Private Space at the Time of the Medieval Transition, 131)

This statute speaks volumes about the aims of the Krakow city council and the methods by which they sought to achieve them. In the first section of the statute, only the *Rynge*, the area immediately surrounding the *Rynek* (Main Market Square) that was singled out for proper cleaning. (Fig. 17) This makes perfect sense if one knows that the *Rynge* is almost certainly where all of the city council members themselves lived. The *Rynek* and the *Rynge* surrounding it, were both the economic heart and the symbolical "face" of the city. Visitors to the city would of course be drawn to the central square where the pride of Krakow was most on display. Florence had its Piazza della Signora, Siena had its Campo, and Krakow its *Rynge*. Keeping

at least this area clean by 1373, was becoming a matter of reputation. The *Rynge* was also the site of the city's most important parish church, *Sw. Mariatska* (St. Mary's). Cleanliness was increasingly seen as close to godliness and it simply would not do for foul dirt and rubbish to build up at the very foot of the Virgin's sanctuary.[72] That the *Rynge* should be the first place where the city council sought to legislate such purity is no surprise. Soon after the regulation was expanded and an addendum attached to the original statute saying, "Also, everyone should, independent of whatever road he is living on, start and shovel in-front of one's house for the whole length and breadth of his property frontage up until the gutter and keep it clean. Following the custom of the city."[73] The fine for noncompliance was again repeated. These cleaning ordinances followed in the wake of all the recent paving projects and everyone was encouraged to keep one's area tidied up in the smarter parts of town. This greater concern for socially prestigious parts of town was certainly not unique to Krakow, as many cities issued special legislation to ensure greater protection of the public "face" of the city, but usually these measures were added as an *addition* to previous norms, not as the only focus.[74] In 1384 the initial regulations were extended to apply to the rest of the city, but even then, compared with similar statues from other towns the regulation comes across as crude and rather behind the

[72]While I disagree with her on many points, Martha Bayless does give some compelling examples of particular concern for excrement amongst the clergy. Special ordinances designed to protect sacred spaces specifically from the accumulation of filth also backs up the idea that churches and church grounds were set apart as "pure" zones where wastes should not be put. As for example was the case in Siena where refuse was not to be thrown onto the property of ecclesiastical structures or cemeteries, especially the piazza outside the bishop's palace. Daniel Philip Waley, *Siena and the Sienese in the Thirteenth Century* (Cambridge: Cambridge University Press, 1991),10-12. For more see: Martha Bayless, *Sin and Filth in Medieval Culture: The Devil in the Latrine* (New York: Routledge, 2013).

[73] The original text, "Auch sal yderman an welchim teyle vnd ende eyner yczlicher gassin her gesessin, si von sinem hüse anczuhebin vnd als vyl ys ym noch der breyte sines érbis adir lenge gebürt, bys in dy helft des gerynnes vor synem hüse schüfelin vnd noch der stat gewonheit reyn halden." Estreicher ed., *Najstarszy Zbiór Przywilejów*, 23, no. 4.

[74]For example: An article from the *statutes* of Siena a set down in 1309-1310, required that latrines and cesspools discharging through the city walls be removed, "for the beauty of the city…" Michael P. Kucher, *The Water Supply System of Siena, Italy: The Medieval Roots of the Modern Networked City* (New York; Abingdon: Routledge, 2004), 76–77. For other legislative cleaning norms in Italy, England, and Scandinavia see: ; Dolly Jørgensen, "Cooperative Sanitation: Managing Streets and Gutters in Late Medieval England and Scandinavia," *Technology and Culture* 49, no. 3 (2008): 547–67.

curve.[75] This lack of progress really showed itself when over a hundred years later, nearly the exact same formula, which had obviously proved insufficient, was used in a re-issued statute calling for better cleaning particularly of the *Rynge*.[76] This legislative response was not sufficient to correct the problems, not even those surrounding the *Rynge* let alone the rest of the city, because they were purely reactive and prohibitive in nature offering no constructive solutions to the systemic problem. The city councilors' goals are readily understandable, but their methods proved insufficient to the task.

Water Legislation

Provisions included within the road cleaning statutes also sought to protect the city's waste water system by preventing people from obstructing the public street gutter channels with crap.[77] This was necessary because too much muck pushed over into the central gutter prevented water from flowing properly and caused, "great disadvantage" to the city as a whole.[78] This legislation was largely ineffective and blocked gutters was a reoccurring problem, but the attempt was made. The council also sought to prevent damage to the gutter system from the flow of too much water or waste material through the channels and in fact charged bathhouses an extra fee for discharging their used water into the city gutters.[79] The city courts arbitrated claims between neighbors over use rights for private canals which linked up to the larger city system.[80] In response to a court case related to this issue—reactively rather

[75] Already in 1272, in Dubrovnik, a city statute stated that "[t]he responsibility for the upkeep of the streets was to be divided between the residents on either side (one third each), while the central third was the responsibility of the commune." While the government of Siena issued an order in 1290 to pave even the alleyways of the city because those which had been left undone were "spilling filth and mud into the thoroughfares which were already (paved)." Robin Harris, *Dubrovnik: A History*. (London: Saqi Books, 2006), 288.
Chiara Frugoni and Arsenio Frugoni. *A Day in a Medieval City* (Chicago: University of Chicago Press, 2005), 305. For larger streets see note 47, for canals and the statute specification post-1296 see details on page 32.
[76] As discussed in the section on water, this re-issuing occurred in 1492: Estreicher, "Najstarszy Zbiór, 27, no. 11.
[77] Ibid.
[78] Ibid.
[79] Jelicz, *Życie codzienne w średniowiecznym Krakowie*, 72-8.
[80] Sowina shows proof of this by looking at records of conflicts between neighbors when such sewage lines cut across multiple properties and when a new party wished to build their own canal and connect to the network. Sowina, "Kanały wód odpływowych," 270.

than proactively—a new statue was issued in 1489. [81] The plaintiff in the case had complained that his neighbor unjustly sent waste-water through a canal which ran across both properties. As no law could be found in the Krakow city books regarding the issues, the question was referred to the Magdeburg court for clarification. The verdict came back that unless the neighbor could prove that the channel had been shared by both parties in the past and he had inherited the right to continue doing so, then it was forbidden that, "excrements, stinking things and waste-water should not be spilled by one neighbor to the other."[82]

Other than seeking to keep the gutter ways clear, the city council does appear to have tried to keep the most egregious activities like tanning, butchering and textile manufacture downstream of the fresh water intake. Anywhere beyond this point however, citizens could empty their industrial waste water or latrine effluence into local waterways and the city moat downstream anywhere they pleased. Indeed, the municipal gutter channels themselves did just that. This lack of concern over waste in the waterways stands in contrast to other cities who took far more aggressive action to protect their local waters from pollutants. [83] This "hands off" attitude by the city council may be due in part to the fact that technically, the city did not own the waters

[81] Estreicher, *Najstarszy Zbiór*, 42-3, no. 37.

[82] The relevant section of the statute reads that, "excrements, stinking things and waste-water should not be spilled by one neighbor to the other; rainwater and clean water should be allowed." The German original reads: "Doch vnlust, stinckende ding vnd spulicht sal eyn nocbar nicht of den andirn gissen, sundir alle regenwassir vnd reyn wassir sal her nicht weren Och das in den hantfesten steyt: frey vorreicht, mag in den Sachen nymantis schaden, wen eyn ider erbe ist frey, das nicht erdczins hath." Ibid.

[83] Some cities zoned particular parts of their adjoining river for dumping, thus protecting the rest, as in Augsburg already from 1276, where two places along the river Lech were set aside. Other cities applied a time-share strategy as in Narbonne, where dyers were permitted to pour their waste-water into the river only at night, so that the waterways would run clear during the day, while in Verona, tanners were under the same nocturnal restrictions., The most aggressive cities, sought to ban the practice entirely. Coventry sought to prevent people from tossing any form of dung, butchery waste, and other muck into the Sherbourne river in 1421 while London gradually banned waste dumping and the building of privies over all its municipal waterways in the 1460s and 70s.
Cembrzyński, *Zaopatrzenie w wode*, 63. Zupko, *Straws in the Wind: Medieval Urban Environmental Law: the Case of Northern Italy*, 82. Dolly Jørgensen, "City Sanitation Regulations in the Coventry Mayor's Proclamation of 1421," *Environment & Society Portal, Arcadia* 2012, no. 8. Rachel Carson Center for Environment and Society. http://www.environmentandsociety.org/node/3853. Folios 121-130: July 1476 onwards in *Calendar of Letter-books of the City of London*, vol. L, *Edward IV-Henry VII* (1912), 142-153, accessed: 2 March, 2016, http://www.british-history.ac.uk/report.aspx?compid=33651&strquery=walbrook. For further examples and analysis of medieval civic government response to river pollution see: Dolly Jørgensen. "Local Government Responses to Urban River Pollution in Late Medieval England" *Water History* 2, no. 1 (2010): 35–52.

from which it drew its drinking supply nor those that surrounded it, as the Rudawa and by extension the city moat were held in fee from the king.[84] This ownership question puts a complaint made in 1533 by King Sigismund I to the Kracow City Council, that the Rudawa was being polluted with, "*sordibus et obscentatibus latrinarum"* and further *"vitiatur et inficitur*" by tanners, and other crafts in an interesting light.[85] For, although the Rudawa was used in great measure by the city its waters still technically belonged to the king and thus he had a strong right to complain. It thus appears that the City Council's lax approach to water-management policy had begun by 1533 to cause significant problems which before, when the city's population was smaller, may not have been as great an issue.

Specific Waste-Legislation

Unlike in other cities, Krakow's statues included no prohibitions against general littering. Residents were expected to keep the space in front of their homes clean whether they had been the ones to create the mess or not. Krakow was among few cities who did not make some regulatory attempt to keep rubbish at bay. For example, Cologne, Nuremberg and Zurich had a general ban on throwing garbage into the street by the first half of the fourteenth century and other cities had even more explicit prohibitions against waste dumping.[86] In northern Italian communes it was standard for city statutes to include detailed regulations against the spilling into the streets such things as, "filth, sour wine, straw, garbage, and wastes." while London had its own set of particularly objectionable rubbish.[87] Without these bans, citizens appear not to

[84] The city had its own "town-waters" as well but this did not include the Rudawa. Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," 11.

[85] The water was being polluted with impurities from Latrines and violated and infected with wastes cast into it by tanners and other craftsmen (*cerdonum et aliorum hominium).* For the full Latin text of the letter is available in: *Acta Tomiciana,* 414-15, no. 301.

[86] Cembrzyński, *Zaopatrzenie w wode*, 62–3.

[87] In London it was said that, "[n]o person should throw straw, dust, dung, sawdust, or other refuse into the streets or lanes" *Liber Albus: The White Book of the City of London,* ed. H. T. Riley (London: Richard Griffin and Company, 1861), 287-92. In Bologna for example in 1288, the city forbid anyone to fling into the important crossroads or piazzas any "stinking or dead animals or any rotten fish or any shellfish or any filthy stinking thing or food scraps, sweepings, dung or prison filth." "Statuti di Bologna dell'anno 1288," in Trevor Dean, *The towns*

have been discouraged from dumping where they pleased and the city's ground level continued to rise.

Latrine Legislation

The question of privies within the home will be discussed in greater detail in Chapter 3. However, to briefly cover their regulation under the civic statues: for a long period after its incorporation, Krakow relied only on the minimal building codes included in the Magdeburg law adopted in 1257 to regulate its architecture.[88] Magdeburg law specified that any "cesspit…shall be three feet distant from the fence…A cesspit adjacent to another man's yard must be enclosed."[89] The two concerns expressed by the law were, that a set distance be maintained between neighbors in order to prevent arguments over smells and latrine leakage on the one hand, and that the cesspit be cordoned off, on the other. As to the first concern, Krakow was in line with other cities influenced by German civic law where the average proscribed distance was 1 meter from a neighbor's property or the public road.[90] For the second concern, the text of the law implies that the "enclosure" was to be an above ground wattle fencing or a hut, and was mandated either out of concerns for modesty - to prevent sight of ones' neighbor doing his business or as a safety measure to prevent animals, children or even

of Italy in the Later Middle Ages (Manchester: Manchester University Press, 2000), 50. For numerous further Italian examples see Zupko and Laures, *Straws in the Wind*, 52.

[88] The *Ius Magdaburgense,* (Magdeburg law) as it was adopted in Poland, was a combination of the land-law (*Landrecht)* of the *Sachsenspiegel* (Mirror of the Saxons) an important German law book and customary complied in 1220, and the *Magdeburg Weichbildrecht*, the basic town law of Magdeburg, first compiled in 1188. Magdeburg. For more on Magdeburg law in Krakow see: Mark R Munzinger, "The High Court of Magdeburg Law at the Castle of Cracow: Legal Actors and Action in the German Law Jurisdiction of Little Poland, 1456-1465," Ph.D. diss., University of Kansas, 2004. The city added an additional limited set of rules governing the laying of foundations and wall construction with particular emphasis placed as always on the *Rynge* in 1367. Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506, vol* 2, 378, no. 266.

[89] Book 2, ch. 51 in Eike von Repgow, *The Saxon Mirror*, 108.

[90] Wroclaw, which had also adopted Magdeburg law re-iterated this statute in 1377, saying that any man could build his privy 1.5 elbows [local unit of measure] from his neighbor's land as long as a brick or wooden wall was placed between them so that no harm should come to the neighbor. While in Elblag (Elbing), which was founded upon Lubeck Law, the rules was that no pigsty or privy could be placed closer than 5 feet from the cemetery nor 3 feet from your neighbor Oddly, as opposed to statutes in other regions of Europe, these regulations appear more concerned with what was going on above ground than bellow. Cembrzyński, *Zaopatrzenie w wode,*78.

adults from stepping unsuspecting into the hole.[91] Both of the issues the law covered dealt more with possible neighborly disputes than concern for managing waste and health. As the law did not outline underground cesspit construction techniques, this meant that stone shaft cesspits were uncommon and only some of Krakow's backyard privies were lined in wood while others were left un-lined and far more likely to seep sewage into the local drinking water.[92] This in spite of known concerns for water purity, expediency trumped health. More stringent regulations common to other polities dictating cesspit construction rules and greater amounts of space between latrines and property lines would likely have contributed to citizens' well-being.[93]

[91] For interpretation of the wording to imply a wattle fence or hut see note. 92 in Eike von Repgow, *The Saxon Mirror*, bk 2, ch. 51.

[92] Thankfully, for public health, these cesspits tended to be sunk towards the back of the plot away from wells which were sited towards the front of the yard demonstrating that some consideration was given to maintaining water purity. Piekalski, *Prague, Wrocław and Krakow,* 89–90.

[93]These regulations were different than those of other areas such as the city of Visby where the city council demanded nearly 3 meters of space between a latrine and a neighboring property. While in London, as early as 1189, cesspits located close to a property line were to be lined in stone and in Bologna where narrow alleys between houses were often used as latrines, these shoots were to be walled up to at least 4 meters in height and made of stone, lime, or daub so that, "passersby receive no injury." ; *Liber Albus,* 279-81.
"Statuti di Bologna dell'anno 1288," in Dean, *The Towns of Italy in the Later Middle Ages*, 51.

Figure 18: Horses and a Horse Trough in the background
(Detail Balthasar Behem Codex, Guild of the Kowale i Konowaly
(The Blacksmiths and Farriers) Folio 297)

It was animal, rather than human waste, however, that caused perhaps the greatest daily challenge. The amount of manure produced in a pre-modern city was no joking matter, a single horse can produce over 18 kilograms of manure and a cow upwards of 24 kilograms per day.[94] Large numbers of animals lived inside the walls of Krakow and wherever they wandered throughout the cityscape, wastes followed in their wake. During the medieval period Krakow had an *Ulica Krowia* (Cow street*), Ulica Świnia* (Pig street) and an *Ulica Psia* (Dog street): [95] unsurprising names, considering that these would have been the most commonly seen animals in the city.[96] Chickens, ducks, and geese would frequently have been let loose or kept in back plot coops, while only the very wealthy kept horses. However, given the close vicinity of the court, these too were a common feature of town. Indeed, an image from the Behem codex, which includes many images of horses, appears to imply that drinking troughs for animals were an element of the city-scape (Fig. 18). Apart from the assortment of "barnyard" animals, pets were another common waste producer in the city. Dogs, cats, birds, and occasionally even more exotic creatures were all kept as pets.[97] A small white dog appears in many of the images of the Behem codex (Fig.19). In the central background of the image of the *Garbaze* (tanners)

[94]Modern beef cattle produce around 27 kilograms of manure while a dairy cow upwards of 35 kilograms. As medieval domestic livestock tended to be smaller than their modern counterparts the amount of waste they produced should be estimated downwards by at around 20% making for an estimated 18 and 24 kilos respectively per day per animal – still a significant amount. "Animal Manure Management," accessed March 19, 2016, http://www.nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcs143_014211.
For horses, 16 kilograms of feces and almost 10 liters of urine combining into 24 kilograms of manure with again a 20% reduction would be in order for medieval stock. "Horse Stable Manure Management (Penn State Extension)," *Horse Stable Manure Management (Penn State Extension)*, accessed March 18, 2016, http://extension.psu.edu/publications/ub035.

[95] Feral street curs were a perennial menace in pre-modern towns. Nicholas, *The Later Medieval City*. 332.

[96] Archeozoological investigations across Greater Poland found that during the medieval period the percentage of bones of various animals: "In the Middle Ages, (defined as 7-13th century A.D.), cattle bone remains constituted from 30 to 50% and those of swine from 28.0 to 52%. In all of the analysed periods goat/sheep remains amounted to 15%. While horse bones remained everywhere below 5%." Likely this number would have been higher in Krakow, however, given the concentration of wealth and nobles in the city. Antoni Jarczyk, Agata Andrzejewska, Małgorzata Wożniak, "Preferences in Meat Consumption of People throughout the Ages Inhabiting the Present-Day Territory of Poland According to Archeaezoological Evidence," *Polish Journal of Food and Nutrition Sciences* 61, no. 4 (2011), 273.

[97] Kathleen Walker-Meikle, *Medieval Pets* (Woodbridge: Boydell Press, 2012), 5–15.

he is actually shown pooing (Fig. 20), perhaps in joking reference to the fact that dog dung was used by tanners in their work. Indeed, dog dung was purchased for a fee fresh from the royal kennels.[98]

Figure 19: Image of the Tanners Guild with a small white dog in the central background.
(Balthasar Behem Codex, Guild of the *Garbaze* (Tanners) Folio 276)

Figure 20: Detail of a Dog Pooing
(Balthasar Behem Codex, Guild of the *Garbaze* (The Tanners) Folio 276)

[98]Used by both dyers and almost certainly tanners. Dembinska, *Food and Drink in Medieval Poland*, 53.

Figure 21: Detail of a Cat Having Captured a Mouse? (Balthasar Behem Codex, Guild of the Futernicy (The Furriers) Folio 244)

Cats, too were also popular companions and an image of a cat chasing a mouse is ironically included in the Behem codex depiction of the guild of furriers (Fig. 21).[99] All of these animals produced a great deal of waste and difficulties thus facing the civic authorities in Krakow were legion but their response appears to have proved inadequate.

For many years, as with latrines, the rules regarding animals in the city continued to be governed by the provisions contained in the Magdeburg law. This in time would prove insufficient. While Magdeburg law contained necessary provisions for administering many aspects of urban life, when it came to waste regulations generally and animals in particular, the

[99] Mice and rats were of course, also common animals in the city but their waste tended to be less of an issue.

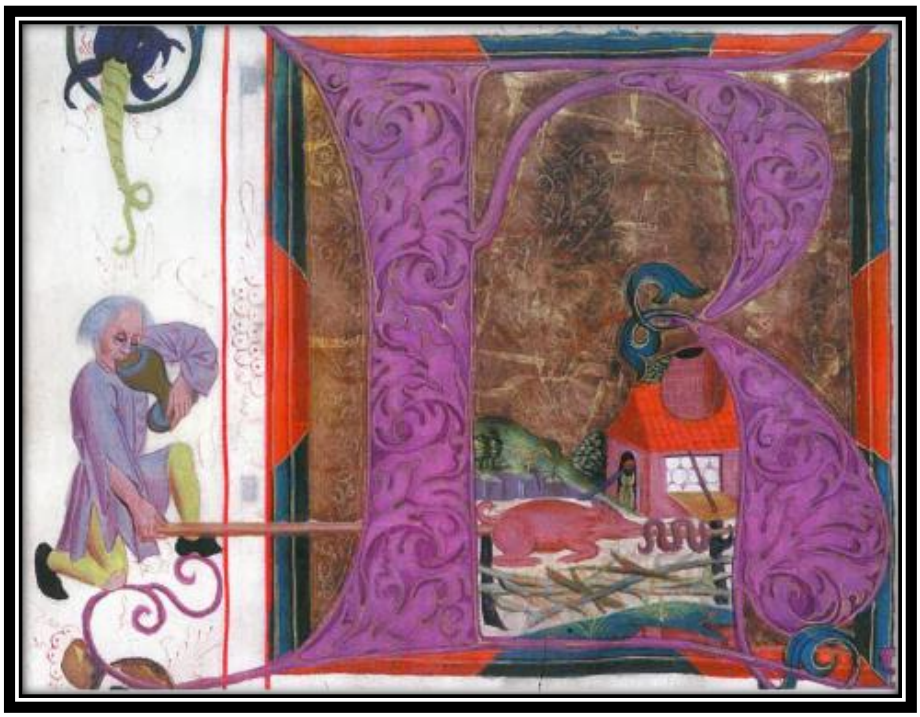


Figure 22 A Peasant Happily Roasting a Piglet and Keilbasa
Initial R and marginal decoration from the Gradual of Jana Obrachta 1499-1506 *Krakow Cathedral Library at the Wawel.* (Baczkowski, *Wielka historia Polski vol. 3. Dzieje Polski Późnośredniowiecznej (1370-1506)* [The Great history of Poland Vol. 3 The Late Medieval Period (1370-1506)], 271)

law provided more guidelines than rules. It only encouraged citizens to pasture their animals on the outskirts of inhabited areas.[100] In the early period of urban formation this meant that animals were housed inside the walls with restrictions tending to push them further out over time. Indeed, while during the fourteenth century all types of animals were still permitted inside the city, attempts began to be made to control their numbers. Pigs, for example, were to be kept beyond the walls except by special permission. Bakers and brewers, however, were granted special license to keep pigs inside because the wastes these industries produced chaff and barley mash-could be most easily disposed of by being fed to a drove of swine (Fig. 22).[101] Yet, even as regulations tightened and Magdeburg law mandated that any pigsty must be

[100] Interestingly, Chełm law, another popular legal code adopted by cities in German and Polish lands appears to have been far stricter with animal provisions than Magdeburg law. Maurycy Zajęcki, "Przepisy dotyczące chowu zwierząt w większych miastach Polski przedrozbiorowej" [Provisions relating to animal husbandry in major cities in pre-partition Poland], *Studia z Dziejów Państwa i Prawa Polskiego* 10 (2007): 111-13.
[101] The bakers of Krakow, throughout the fifteenth century, were permitted to keep up to 24 pigs for just this purpose. Zajęcki, "Przepisy dotyczące chowu," 113.

situated at least at a meter's distance from a neighboring property, it was only in 1554 that a statute was issued that required that pigs must be kept penned at all.[102] The assumption being, that before this date they were permitted to roam the streets at will. At long last in 1639 was the keeping of pigs within the city walls banned completely.[103] These dates make Krakow appear ridiculously behind the times compared with other polities. London for example, banned pigs from city streets in 1277, and not without good reason as pigs could be aggressive, at times even dangerous animals.[104] Nuremberg meanwhile, had a law preventing anyone from bringing more than three pigs into the city at a time except by special permission and even then only if a swine-herder was there to guide them.[105] Yet, there may have been a method behind the seeming madness as some cities took the opposite approach and actually had a pig-keeper on their pay-role explicitly for cleaning purposes.[106] For, while pigs loose in the city, could at times prove dangerous, they would also forage carrion and eat the dung of other animals acting as living urban vacuum cleaners. The Krakow statutes granting special concessions to messy mash producing professions to keep pigs implies this might have been the case in Krakow as well. Taking this possibility into account, the late date of Krakow's banning pigs from the within the walls seems less strange as the pigs might have actually contributed to the city's cleanliness. The fact that cows who afforded no such benefits were also permitted to be bred

[102] Ibid. Book 2, ch. 51 *The Saxon Mirror:* Eike von Repgow , 108.
[103] Zajęcki, "Przepisy dotyczące chowu,113.
[104] Cases of people being attacked and of children being killed by pigs were unfortunately commonplace. Beginning in the thirteenth century, animal trials became a feature of the legal landscape where rouge pigs and other beasts were literally taken to court, tried, and hung. Mark Essig, *Lesser Beasts: A Snout-to-tail History of the Humble Pig* (New York: Basic Books, 2005), 96-7. R. J. Magnunsson, "Water and Wastes in Medieval London," in *A History of Water*, vol. 1, *Water Control and River Biographies*, ed. Terje Tvedt (London: I. B.Tauris, 2006), 311.
[105] Nicholas, *The Later Medieval City.*,331.
[106] This was the case in the city of Siena which from the year 1296 sold the contract for the gathering of all garbage, manure, and spilled grain in the central Campo piazza to the highest bidder and authorized the use of "a sow and four piglets so they can gather and eat all the spilled cereal." While in fourteenth-century Florence, the *Porci di San'Antonio* were special pigs dedicated to St. Antonio were permitted to roam freely through the city as privately owned pigs were not functioning as municipal cleaning machines, munching up the refuse left in the streets. Chiara Frugoni and Arsenio Frugoni, *A Day in a Medieval City* (Chicago: University of Chicago Press, 2005), 65-9.

and housed within the city up until 1639, however, shows that perhaps there was instead simply a lack of zeal for animal waste management.[107]

Enforcement

Records indicate that the Krakow city government appears to have taken few steps to enforce its waste legislation. Thus, even if the legislation issued by the city had been more comprehensive, without accompanying means to see to its implementation the words would remain merely symbolic. Again, examples, from other cities show that this need not have been the case. In many places, city wardens and police were tasked with handing out citations to citizens who had not kept their areas sufficiently clean.[108] If the task was too much for the local law enforcement to handle, cities could follow the example of Avignon and Stockholm, who independently developed a particularly ingenious method for co-opting their citizens to do the dirty work for them by agreeing to pay one third of any fine resulting from a waste infringement to those who ratted out their neighbor's bad behavior.[109] In cities where garbage collection went on, fee collectors went along with the clean-up crews to make sure residents paid their fair share.[110] Krakow, for its part had an official police force known as *circulatores*,

Zajęcki, "Przepisy dotyczące chowu, " 116.

[108] In Coventry, the common sergeant together with the town crier followed behind the weekly garbage cart and issued citations to residents who had not properly cleaned their stoops. By 1300 Mainz had an inspector who enforced the city's building codes and oversaw street cleaning. In Nuremburg, the city's "master-builder" was responsible for not only maintaining the city's roadways and sewer-channel system but also ensuring that all public areas were kept clean and the watercourses were kept from becoming overly-polluted. In many Italian communes meanwhile, the *Podesta* or *Capitano* was to enquire closely into all privy or dirt related complaints and his word was to be taken as law regarding any infringement of these ordinances. Jørgensen, "Cooperative Sanitation," 563. Cembrzyński, *Zaopatrzenie w wode,* 57, 64. Rosemary Horrox, *The Black Death* (New York: Manchester University Press, 1994), 198.

[109] The *Customes* of Avignon of 1243 stated that, "Likewise, we decree that no one shall throw water onto the street, nor any steaming liquid, nor chaff, nor indeed any dirt. Nor shall he throw anything into the street under his house nor allow his family to do so. And he who commits this offense, be he head of the family or not, shall pay a fine of two shillings for every offense; and his accuser shall receive a third of the fine." M. A. R. de Maulde, 'Coutumes et reglements de la Republique d'Avignon" In *The Medieval Town,* ed. John H Mundy and Peter Riesenberg (New York: D. Van Nostrand Company, 1958), 157-58. This example from Stockholm comes from the sixteenth century, but the city had had regular cleaning crews in place from at least the fifteenth. Jørgensen, "Cooperative Sanitation," 559, 564.

[110]In London, special representatives of the city council were sent along with garbage crews to see that fines and fees were properly collected. *Liber Albus*, 287-92. Jørgensen, "Cooperative Sanitation," 563.

who were issued arms by the city and paid 6 grosz per week to track down criminals and keep law and order. However, the records give no sign that they attempted to enforce rules of cleanliness. [111] The city finances also do not record a great list of fines being added to the plus side of the ledger, further promoting the notion that the enforcement of the waste statues was either non-existent or carried out in such a way that it does not appear in the records.[112]

Court Records

Very few court cases relating to waste appear in Krakow's records and these all involved boundary disputes between neighbors, with waste concerns being secondary to the issue. [113] In two cases involving Krakow's Dominican chapter, a latrine was built uncomfortably close to the boundary line, less than the three feet specified in the Magdeburg customary law adopted by the city, and was ordered moved elsewhere. [114] In another case a certain Thomas Scholcowi connected his own sewer canal to that of his neighbor and flooded it with "*aquas immundas sordesque.*"[115] The neighbor complained to the city court who after looking into the matter ruled that Thomas indeed had no right to make use of his neighbor's sewer canal and ordered him to cease and desist.[116] In both of these cases however, the issue at hand had far more to

[111] Kutrzeba, *Finanse Krakowa w wiekach średnich*, 89.
[112] Carter, *Trade and Urban Development in Poland*, 26.
[113] In searching for court documents recording waste-related cases I have consulted what records are available in edited form and found no mention of waste related infringements. As the court records I have been able to access represent but a small sample of those carried out during the period this may account for the lack. In her work, Sowina has brought to light suits related to waste-water canal conflicts in the unedited *Consularia Cracoviensia.* It is likely that similar cases related to waste remain still hidden in the *Archiwum Państwowe w Krakowie*, (Krakow State Archives) which I have not accessed. Further research is needed, to fully answer this question. The court records I have been able to access are included in Bożena Wyrozumska, *Księga proskrypcji i skarg miasta Krakowa: 1360-1422: Ze zbiorów Archiwum Państwowego w Krakowie* [Book of complaints and the proscription of the city of Krakow : 1360-1422 : From the collections of the State Archives in Krakow**]** (Krakow: Wydawn. i Drukarnia "Secesja," 2001).
[114] Cembrzyński, *Zaopatrzenie w wode*, 79.
[115] The original case from 1533 can be found in: Archiwum Państwowe w Krakowie, [The Krakow City Archive] Consularia Cracoviensia 435 s. 116. Recorded in Sowina, "Kanały wód odpływowych," 272.
[116] Ibid. This case should have been very cut and dry as a 1489 statute responding to an almost identical question in an earlier case had been referred to the Magdeburg law court for instruction and had come down firmly that neighbors were only obliged to share canals if they had done so in the past. Estreicher, *Najstarszy Zbiór Przywilejó*, 42-24, no. 37.

do with boundary line concerns and rights of use than waste complaints as such. These were also civil suits and not anything brought against citizens by the commune directly. To top everything, in both cases the same issue came up again in court 2-3 years later. This shows that although the order had been given, it had not be executed, demonstrating that enforcement of regulations even after having been brought to trial was lax.[117] It was perhaps this inability to enforce whatever minimum standards might be put in place that helped lead to Krakow's seemingly well-deserved dirty reputation. It was perhaps this inability to enforce whatever minimum standards might be put in place helped lead to Krakow's seemingly well-deserved dirty reputation.

Public Services

Lack of Public Garbage Services

Krakow, unlike many other cities does not appear to have designated zones beyond the city walls to act as communal garbage dumps.[118] The city's environment might have been greatly improved had the civic authorities provided a proper location for their waste to be taken, or had

[117] Thomas Scholcowi, as it happened appears to have had friends in very high places as he appealed to the King, who ruled in his favor, but the city continued to consider his neighbor an injured party. Sowina, "Kanały wód odpływowych," 272.

[118] I have found no evidence in any of the city statutes or records that a municipal dumping site was ever established. It is possible that private citizens carted dung out beyond the city walls, perhaps even for sale to city farmers but as toll-gate records were kept applying only to foreign goods and traders, such an event would not appear in the records. However, considering how multiple archeological and archeo-botanical reports have commented upon the large amount of animal dung found in sites all over the city, this implies that most waste was not carted beyond the city walls. Evidence of dung has been found even in the central market square which, in keeping with civic statutes should have been the cleanest area of the city. The Krupnicza site, in the former Garbary district was apparently used at some point after the fifteenth century as a waste dump beyond the city walls, but its size implies it was a private midden and not a city garbage heap. Piekalski, *Prague, Wrocław and Krakow*, 152; Tadeusz Sokolowski et al., "Changes of Natural Environment in Kraków Downtown: Its Chronology and Directions; Case Geoarchaeological Studies of Krupnicza Street Site," *Geochronometria: Journal on Methods & Applications of Absolute Chronology* 31 (May 2008): 17.. Aldona Mueller-Bieniek, Adam Walanus, and Emil Zaitz, "Cultivated Plants in Medieval Kraków (Poland), with Special Reference to Amaranth (Amaranthus Lividus L. Cf. Var Lividus) and Ruderal Communities," *Acta Palaeobotanica* 55, no. 1 (2015): 105, doi:10.1515/acpa-2015-0003.

made efforts to remove it themselves with a public cleaning brigade.[119] As late as 1574, citizens were still being encouraged to dispose of their rubbish and compost generically "outside the city", with no location specified.[120] Indeed, Without having a good place to put the dung dutifully shoveled 16 ells from ones front door, Krakow residents appear to have all too commonly pushed their piles into the central gutter causing obvious problems for the canal system or else off onto their neighbors' section of the street.[121] Having not even bothered to site a place for wastes to be carted to beyond the city limits, it is unsurprising then to learn that Krakow did not have a regular garbage collection crew. The first mention of any attempt to implement such a system does not appear in the records until 1592, and even then was quickly abandoned as it proved unsuccessful.[122] Here again, the absence of such services in Krakow stands in sharp contrast to many other cities of far less royal pedigree.[123] This want of initiative

[119] It was common practice for cities to designate areas beyond the walls as public middens. For a few examples: Nuremberg and Wrocław as well as Coventry, York, London by the early sixteenth century, and in most cases well before. Dolly Jørgensen, "What to do with waste?" in *Living Cities: An Anthology in Urban Environmental History*, ed. Matthias Legnér and Sven Lilja (Stockholm: Forskningsrådet Formas, 2010), 51–2. Cembrzyński, *Zaopatrzenie w wode,* 64.

[120] "*Błoto, gnoje, żeby każdy do tygodnia wychędożył i wywiózł pod winą i karaniem na ratuszu*." [Mud, compost must be disposed / taken out (side the city), otherwise facing being found guilty and punished at the Rathaus.] In the same order, citizens were encouraged to keep their chimneys in good order, have water available in buckets to quench any outbreaks of fire, and keep their pigs from roaming freely about the city. These mandates, appear as little more than a re-issuing of the regulations defined in the code of the Magdeburg law originally adopted by Krakow in 1257. "Ulice" [Streets], Stary Kraków [Old Krakow], accessed March 1, 2016, http://www.starykrakow.com.pl/.

[121] The re-issued statue regarding the cleaning of the *Rynge* from 1492 records problems with such improper sweeping stating that, "the town council…recognizing that the town is suffering great injustice and disadvantage from those who are living on the *Rynge* who carry their rubbish, trash, and excrement and shovel and push it over the borders and the city has to take it out with great problems…" . Estreicher, "Najstarszy Zbiór, 27, no. 11. The original text of the statute runs in full: "Dy herren jungk vnd aid ansehende das der stad gross vngerecht vnd korcze geschit von den, dy am ringe wanen, dy ire kot vnd vnlust tragen, schawfelen vnd stossen obir yre greniczen vnd dy stad musz is awsfuren in gros beswernisse, darvmme eyn sulchs zu vormeyden, haben beslossen vordan zu halden, das eyn ydirman der am ringe wanet sal aliis kot awsfuren von seynem hawse bis an das gerynne, is sey wy ferre, das sey ane alle awsrede; vnd so yrkeyner aws den hawsirn etwas trüge adir schüttet, der sal eyn schok busse geben, wen wir willen das der ringk reyne sey."

[122] In this year the city sought to impose a fee upon homeowners for the removal of their trash by hired-hands but collection proved difficult and the program was abandoned soon after. "Ulice" [Streets], Stary Kraków [Old Krakow], accessed March 1, 2016, http://www.starykrakow.com.pl/.

[123] Already in the thirteenth century, Siena had six official city street cleaners on the municipal payroll. By the fourteenth century, London had its beadles and rakers whose jobs it was to take away all "straw, dust, dung, sawdust, or other refuse…to the places ordained for receiving such dirt." and to collect their entitled fee from local residents for the service. While other English towns of York, Coventry, and Norwich, even smaller in comparison to Krakow had carts which made weekly garbage runs. Strasbourg had street cleaners and trash men making weekly rounds beginning in 1405 with Dijon and Compiegne following its example soon after. The city of Elblag saw to it that at least twice a year the most important areas of the city saw a good wash." Buda retained a garbage man year-round known as the "Manure Count." By the sixteenth century, Paris, had its famous "fifty

on the part of the city fathers is doubly strange when one considers that such a program may well even have been in their economic interests to do so. During the pre-modern period and still today in many parts of the world, manure has been highly valued as fertilizer.[124] In cities which had a municipal cleaning squad, these workers could take the dung they had collected and sell it to farmers beyond the city walls while in other cases, dung was donated to local religious houses or benevolently left free for the peasantry to take. [125] To be properly utilized, such manure had to be gathered fresh and distributed on the fields as quickly as possible before it lost its nitrogenous potency, this time constraint of course further stimulated regular rounds of the dung collection cart. The city fathers of Krakow, however, appear to have done none of this in any way that has come down to us in the records.[126] Manure and human feces built up instead in back lots where to a point it was useful as fertilizer for the personal plots tended by many residents, but as the city population expanded, the amount of waste generated soon far outstripped the demand within the city walls. Lacking a proper outlet however, the waste simply built up, making its way all too often from the back garden into the city streets.

masters" who helped remove 800 carts of waste twice daily. David Nicholas, *The Later Medieval City: 1300-1500* (London: Longman, 1997), 332, 334; *Liber Albus*, 32-35; ; André Chédeville et al., *Histoire de la France urbaine. des Carolingiens à la Renaissance*, vol. 2, ed. Georges Duby (Paris: Seuil, 1980), 572; Cembrzyński, *Zaopatrzenie w wode*, 62–3.; Lynn Thornsike, "Sanitation, Baths, and Street Cleaning in the Middle Ages and Renaissance," *Speculum* 3, no. 2 (1928), 203.

[124] Hops growers in thirteenth century Małkowice are the first recorded group in Poland to haul and spread animal manure on farmland to increase production. However, the practice was likely ongoing well before this first textural reference. ;Richard C. Hoffmann, *Land Liberties, and Lordship in a Late Medieval Countryside: Agrarian Structures and Change in the Duchy of Warsaw* (Philadelphia: University of Pennsylvania Press, 1989), 52, note 112.

[125]In Spoleto, for example, waste from the *capitan* of the city's stables was delivered to the brothers of the order of the sacred friars. While in York from 1550 onwards, peasants were permitted to take away dung free of charge from the city heap for manuring their fields. Zupko and Laures, *Straws in the Wind*, 62. Jørgensen, "What to Do with Waste?," 52.

[126] In the civic records there is no mention of any type of organized trash removal program. Very occasionally, when the situation became truly unbearable, the city appears to have paid to remove the worst of the offending trash as the complaint in the re-issued statue regarding the cleaning of the *Rynge* from 1492 demonstrates. Estreicher, ed., *Najstarszy Zbiór Przywilejów* 23, no. 4.

Lack of Public Latrines

Krakow appears to have had no public latrines. It has been claimed that privies were set up around the central market and used especially during annual fairs but this appears to be more wishful thinking than reality, as there is no evidence from the records to back up these assertions.[127] Other cities did have public facilities and it is possible that Krakow did as well, the records of which has simply not come down to us.[128] However, given the human excrement mixed in with other muck uncovered in archeological excavations in Krakow's main market square, the cleanest place in the city, it is equally possible that it did not.[129]

City Fresh Water Services

The one service that was managed very effectively in the city of Krakow, was the public water supply. This precious resource was important for drinking, but also for cleansing of the city. The Krakow water system began to develop beyond a series of public wells into a piped water system with the appointment of the first city *rurmistrez* in 1385, but the project really took off after 1399 when a group of wealthy burghers took an interest in the effort; including a former merchant of Genoa who was on the City Council and Managers of Krakow's local mines, who were familiar with more sophisticated water moving technology.[130] In her work, Urszula Sowina, points out that sites near the homes of these men were the first to be hooked up to the

[127] I have found no records in the city statutes or finances that show the existence of a public latrine despite Płaśnik's assertions. Jan Płaśnik, "Towns in Medieval Poland," in *Polish Civilization: Essays and Studies* ed. Mieczyslaw Giergielewicz and Ludwik Krzyzanowski, eds (New York: New York University Press, 1979), 36.

[128] London had public amenities from as early as 1271 while Westminster is known to have had public latrines built and paid for by the city from at least the fourteenth century: "Folios 81 - 89," in *Calendar of Letter-books of the City of London*, vol. A, *1275-1298* (1899), 172-85, accessed June 6, 2012, http://www.british-history.ac.uk/report.aspx?compid=33028&strquery=conduit. Gervase Rosser, *Medieval Westminster 1200-1540* (Oxford: Clarendon Press, 1989), 69.

[129] For descriptions of waste, excrement, and dung found in Krakow sites see: Piekalski, *Prague, Wrocław and Krakow*, 152; Sokolowski, "Changes of Natural Environment in Kraków Downtown," 17; Mueller-Bieniek,"Cultivated Plants in Medieval Kraków,"104-5.

[130] Italian water supply systems were by far the most advanced of any in Europe. At the same time, local mine operators, in particular those at the nearby Wieliczka salt mine, had been developing increasingly sophisticated methods to pump water from their shafts for the last hundred years. Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," 13–14.

new system, implying that civic elites encouraged the development of the new system solely for their own benefit. She writes, "[i]t was often declared that the pipe water supplies was *pro bono public*o. Watching the history of the Krakow network, one can observe that this *public good* was actually the good of the town's patriciate."[131] She may have a point, after all, water and waste management in Krakow was controlled by the city elites and thus reflected first their desires and interests. However, given that the elites of the city tended to live on the *Rynge* facing the central market square which was the focus of all social and economic life in town, it is also only logical that the water supply would also be first introduced in this busiest central location where the greatest number of people would have need of it. The oath taken by the city *rurmistrz* Marcin in 1436, also undercuts her argument as he vowed,

> I will produce and administrate the pipeline faithfully and piously and will faithfully provide the water always to everyone, which is to the profit of the city and the breweries, bathing houses, and all other places being piped, and I will see this done. In the same way to everyone without any advantage or obstacle to anyone, without any cheating.[132]

This oath, demanded of the new pipe master by the city council itself states that no special favor should be given to anyone, but rather that the pipes should be put in place for the benefit of the city as a whole rather than merely its elite. This could be just so much sophistry but the fact that the first record of an individual home being connected to the system appears in the

[131] Ibid.,15.

[132] The full oath as recorded in the city notary book in its original German reads: "Iuramentum aqueductoris, rormagistri Ich swere gote, das ich meinen herren den rothmannen jungk vnd alth, dy itczunder sitczen vnd hernoch mols sitczen werden getrew vnd alleczeit gehorzam seyn will vnd meyn amecht des rorwergks getrewlich vnd fromlich vorwezen wyl vnd das wasser alleczeit einem iderman, do is meyn herren czw der stad nutcze yn brewhewsern, badstoben vnd an allen anderen stellen geletet haben, getrewlich fordern wyl, gleich einem als dem andern vnd an allen forteil, vorstoppunge vnd hindernisse wil lossen, gehn vnd Hissen an alle betriglichkeit, vnd der stad roren dy ich entphoe vnd boren werde getrewlich vorrechen, czelen vnd legen vnd alles gerethe, geschirre vnd notdorfft holczen vnd auch eyserne, das ich itczunder habe ader nochmols haben werde, was mir oberantwert wirt, von der Stadt nicht entwenden wil an meinem ader süst erkeinem nutcz, vnd alles was ich erfaren werde, das der stad schedlich were, ader meinen herren rothmannen, welcherley das were, das ich das offinbaren wil, vnd allen der Stadt schaden mit meinen höchsten krefften als ich kan vnd magk bewaren wil, vnd wil das nicht lossen durch lip noch durch leyt, fruntschafft, fintschafft, gunst ader gobe, noch süst durch keyner Sachen willen. Als myr got helffe vnd dy heiligen." Estreicher, *Najstarszy Zbiór Przywilejów*, 51, no. 22..

municipal accounts in 1441, and this only for a considerable fee leads one to think that more than likely it was not.[133]

The supply of fresh water was obviously of great importance to the city council as a great deal of effort was expended to expand the system as other waste-related services were not. This effort was likely aided by the fact that due to the taxes levied for access to the new piping, supplying fresh water became a money-making venture for the city. This tax revenue came primarily from three types of hook-ups, first bath houses, and breweries and in time private homes, at first only those of the wealthiest citizens and then expanding to include more homes throughout the century.[134] Indeed, thanks to the water provided by the *rurmus* system, Krakow became renowned for its brews and became a major exporter of beer so that by the early sixteenth century the city housed over two hundred breweries.[135] This boom in beer was also a boon for the city as the breweries were charged a special tax known as *rorgelt* for access to the city pipes.[136] Tax revenue was also collected from the public bath houses, of which there came to be at least twelve in Krakow.[137] The taxes for water hookups provided the city with a tidy profit making the water system a net positive in the account books despite the initial heavy investment. This of course meant that the civic authorities had a much greater incentive to protect this public good more than the public thoroughfares whose cleaning was a net drain. Bathhouses and breweries thus flourished under the new system. By investing in Krakow's

[133] Kutrzeba, *Finanse Krakowa w wiekach średnich*, 42.
[134] And yet, "Brewers were always of two minds about pollution. They wanted clean water but also the ability to get rid of the waste in the easiest way," usually by dumping it back into the water system. Complaints in Krakow from the sixteenth century about brewers dumping malt mash into the city roadways demonstrates this paradox. Ibid.;Richard W. Unger, *Beer in the Middle Ages and the Renaissance* (Philadelphia: University of Pennsylvania Press, 2004), 40.
[135] Beer was incredibly important to daily life. In Germany it is calculated that a single individual drank 300 liters per year, while along the Baltic coast, the amount was even higher, rising from 400 to 600 liters per person per year by 1600. Gdansk, in 1416 had 378 breweries one of the highest anywhere, exceeded only by Hamburg which had around 500, Krakow remained in the top 5 % with 200. Richard W. Unger, *Beer in the Middle Ages and the Renaissance*, 40, 121-23,132. Carter, *Trade and Urban Development in Poland*, 162.
[136] Kutrzeba, *Finanse Krakowa w wiekach średnich,* 41.
[137] Rent paid to the city by a bath proprietor was ½ *gnywny* per week plus an additional city tax, fee for the water provided by the pipe system, and an additional fee for the initial hook up and instillation of water-pipes. Ibid.; Jelicz, *Życie codzienne w średniowiecznym Krakowie*, 72–3.

water infrastructure the city council promoted civic well-being and simultaneously provided itself with a steady revenue stream. Krakow's fresh water system, with the initial siting of its "water tower" upstream of both industrial activities and the city's main waste-water canals, can be considered a major waste-management success.

Thus, it appears that up until the mid-sixteenth century, Krakow may indeed have been the dirty place depicted by Conrad Celtis and artfully painted over with a generalizing brush by Ciołek. The cause for this lies not with the basic infrastructure of the city which appears to have been at least on par with or indeed superior to that of many other cities. Rather, it was the civic authorities' failure to issue sufficient legislation, to guarantee the enforcement of what little legislation there was, and to organize street cleaning initiatives that lead to the continued buildup of crap in Krakow's streets. The question then remains: why did Krakow's government fail to take more aggressive action?

Why Did Krakow Have Such Poor Waste Management?

Krakow suffered from a number of internal political issues and external pressures that combined to limit the city councils ability and interest in reforming its waste management system. Firstly, the city was hampered by the close proximity of the king on Wawel hill. Cities that enjoyed greater self-autonomy had correspondingly greater flexibility to adapt their internal regulations as required without needing to have it rubber stamped by some higher and often absentee authority. The residence of the king and his direct control over assets, normally in the keeping of the town, such as the all-important Rudawa River also hindered development.[138] The ambiguous status of the Rudawa, technically owned by the king, but administered by the city meant that the buck of responsibility for dealing with problems when they arose was tossed back and forth between the two resulting in little being resolved. Funding for civic improvements was also an issue as the king's approval was required for the levying of taxes that for example might have gone to help pay for better statute enforcement or an internal garbage collection system.

Secondly, reinforcing the effect of the king's oppressive presence was the early hamstringing of the Krakow city council's political power in the wake of an unsuccessful rebellion led by city officials in 1310.[139] This greatly complicated matters as, unlike in other places, civic elites had less power to influence the commune, which meant that they were less invested in its

[138] The city had its own "town-waters" as well but this did not include the Rudawa. Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," 11.

[139] For details of the revolt which is related by Jan Długosz, and its later effect on the city council, see Paul Knoll, "Urban Development of Medieval Poland with Particular Reference to Kraków," in *The Urban Society of Eastern Europe in Premodern Times*, ed. Bariša Krekić, (Berkeley: University of California Press, 1987), 90–2.

success. Combine this with the fact that the city council was dominated by a merchant patriciate, whose origins and interests often lay elsewhere, and you had a recipe for apathetic inaction. That Krakow's elites never developed as strong a sense of civic pride and interest in the city as those in other places had a great impact on the efficacy of its waste management.[140] Competition amongst the city elite for civic position and local prestige was elementary for improved sanitation. Cities often relied upon public patronage from their elites to see civic improvement jobs done. Places like London which had regularly elected officials and early on gained significant autonomy from the crown, and the Italian republics, where oligarchic cliques vied for power, had impressive waste removal programs. Meanwhile Krakow lagged. In this respect, the Italian republics were uniquely advantaged as a local culture developed which channeled expressions of power through the public display of wealth in sponsored civic building projects—magnificence through munificence. As the current political faction sought to outdo its rivals and display their legitimacy through ever more impressive improvements to the city. Civic humanism had its roots in Italy for a reason. Krakow's elite on the other hand, while they did seek to improve the facilities of the city, but never invested their private wealth to the same degree as was popular elsewhere in more competitive societies.

As if this were not enough, the city's very legal system appears to have been designed to prevent easy adaption of better waste management measures. Due to Krakow's adoption of Magdeburg law as its basic civic code, when a complaint or question arose on any thorny mater, the Krakow jurists checked the law for what ought to be done. However, given that Magdeburg law was very light on waste related legislation jurists often referred such cases to the Magdeburg city court for advice in a long, and as the records show, often futile process.[141]

[140] Ibid.

[141] Although in theory Krakow became a "high-court of appeal" for Magdeburg law in Poland, in practice, documents show that city councilors still referred questions back to the mother city. Mark R. Munzinger, "The Text and Textualization of Codex BJ 168: Legal Culture in Transition at the High Court of Magdeburg Law at the Castle of Kraków," *Krakowskie Studia z Historii Państwa i Prawa* 4 (2011): 24–5, http://www.ejournals.eu/sj/index.php/KSzHPiP/article/view/1887.

Instead of ruling on the issue immediately, or writing a new law to combat the problem as cities with their own internally generated civic codes might do, jurists followed standard procedure which proved inadequate to produce solid waste legislation. In this respect, cities in England had an advantage as, developing under common law, they relied on an expanding set of continually growing internal precedents which allowed for relatively quick formation of new legislation.

The problems with the legal system went beyond drawn-out Magdeburg procedure however, as Krakow's extremely complex juridical map added another layer of complication. As it happened, not everyone in the city was even punishable under Magdeburg law should it have incorporated robust waste regulations. Instead, various sets of legal codes applied to individuals, depending on their origin and status. Official citizens of Krakow, often of German origin, were governed by the Magdeburg code. Polish peasants meanwhile, were dominated by a separate set of feudal rules and Jews in the city fell under the direct protection of the king. At the same time, nobles held unique privileges, as too did church lands and members of the clergy ran their own courts. Foreign visitors might appeal for exemptions and internal university matters remained outside of the city's control entirely.[142] With such a complex interweaving of privileges and exemptions, a unified program of administration was very difficult to establish. It is perhaps partly because of this complexity that the city's finances and budget was never properly organized during the period, which *also* held back improvements. This was the case, despite the treasury being managed from 1372 by a former Genoese silk merchant who one assumes would have been aware of the revolution in financial planning

[142] Wojciech Wasiutyński, "Origins of the Polish Law, Tenth to Fifteenth Centuries," in *Polish Law throughout the Ages*. ed. Wenceslas J. Wagner, (Stanford: Hoover Institution Press, 1970), 49-52.

which had been developed first in his home city some thirty years previously.[143] The city thus found it quite difficult to wash its hands as both legally and financially they were tied.

Lastly, it is ironic that Krakow's remarkable and as yet not fully explained escape from the first wave of the Great Plague in 1348 meant that public pressure to improve sanitation for fear of the spread of disease was catalyzed at a later date than in most places. Whenever an epidemic struck a medieval city, a sudden flurry of sanitation initiatives and new legislation can be seen in the records. This trend can also be seen in Krakow, but because outbreaks of the pestilence amongst the population only occurred beginning in the mid fifteenth century, improved sanitation measures were similarly behind the curve.

Yet, it was also of course the case that Krakow's relatively small size throughout the thirteenth through sixteenth centuries meant that conditions, while perhaps distasteful, never tipped over into unbearable, causing enough public pressure to push a major change to the system. By remaining a city of under 18,000 people, Krakow never hit a point when their authorities were forced to move far beyond doing things the way they had always been done. I do not believe that the people of Krakow were less sensitive to disgusting odors or the piles of muck that filled their streets, but given the fact that a fix to the problem was so difficult to achieve given the many factors stacked against it, people put their heads down, plugged their noses, and continued to trudge on through.

However, by the mid-sixteenth century something had changed. Krakow's ground level ceased to rise and the hygienic level of the city appears to have improved in-spite of the fact that organized garbage collection did not occur until at least the seventeenth century. What promoted this change and how did it come about?

[143] "The Oldest Example of Double-Entry Bookkeeping," *Bulletin of the Business Historical Society* 4, no. 4 (1930): 11. Urszula Sowina, "The Relations of the Town of Kraków and Its Patriciate with the Ruler and the Wawel Court from the Thirteenth Century to the First Half of the Sixteenth Century," 231, accessed January 31, 2016, http://brepols.metapress.com/index/N485P4U812521577.pdf.

Sixteenth Century: Improved Sanitation?

In 1492, as discussed, the town council re-issued statutes enforcing earlier orders to keep the roadway in front of one's own property clean. In 1494 a massive fire swept through the city destroying property but also making room for new infrastructure projects, shortly after in 1498, as fear of a seemingly eminent Ottoman invasion swept through the city, a frantic effort was made to build-up the city fortifications and further improvements were made. [144] No invasion came however, and the Krakow burghers continued to grow in wealth and prestige in the wake of the expansion of the Kingdom of Poland. By 1505, there are signs of a greater concern for public health and order. The first municipal doctor was appointed in that year and the codex of Balthasar Behem, compiling the city's privileges, laws, and guild statues was commissioned.[145] The early sixteenth century also saw Krakow at the height of its *Złoty Wiek* (Golden Age) as major changes occurred at the court, in particular after King Sigismund I married the Italian Bona Sforza of Milan in 1518. The Polish Renaissance blossomed as new styles were introduced by imported Italian artisans and a new modern castle was built on Wawel Hill. The king may have complained about the tainted water supply and that the common folk were pouring filth from upper-floors, but archeological evidence shows that by the early sixteenth century, Krakow's ground level stabilized and the muck diminished significantly.[146] This may be attributed to pushes made by King Sigismund in this area to goad the council into addressing the problem more forcefully. In his letters to the council, King Sigismund I demanded that a thorough inspection be made of all the city gutters and that they think of ways to improve the

[144] Jacob Litman, *The Economic Role of Jews in Medieval Poland: The Contribution of Yitzhak Schipper*, (Lanham: University Press of America, 1984), 202-3.
[145] Carter, *Trade and Urban Development in Poland*, 365.
[146] Piekalski, *Prague, Wrocław and Krakow*, 152.

cleanliness of both the streets and waterways and protect them from dirt. [147] Soon after, in 1543, the city council was taking more proactive steps to ban the flooding of the streets with organic waste in hopes of mitigating an outbreak of plague.[148] From 1554, greater restrictions were placed on keeping animals within the city walls, and finally, a year before the Polish-Lithuanian commonwealth was formed, the Krakow city council ordered an annual account be taken of the city's infrastructure and architectural deficiencies, and that measures be taken to remedy them. These audits were carried out in each of the city's four quarter-districts and recorded in the *Quartaliensium Recognitiones et Divisiones* beginning in 1568.[149] Efforts continued to improve the city over the following centuries but the transfer of the capital to Warsaw and the invasion by Swedish forces in the seventeenth century meant that even as civic organization improved, the pace of progress was slow.

[147] Sowina, "Kanały wód odpływowych,"271-2.
[148] Sowina, "Kanały wód odpływowych,"273.
[149] *Księga wiertelnicza krakowska Quartaliensium recognitiones et divisions 1568-1577* [Quarter books of the city of Krakow 1568-1577], vol. 1, ed Jelonek-Litewka, Krystyna, Aleksander Litewka, and Łukasz Walczy (Krakow: TMHiZ, 1997).

Chapter 2 - Industrial Pollution

Noxious waste products left over from industrial activities are not a creation of the modern era. Humans have for millennia been tainting their environment with the leavings of their industry. During the medieval period, demand increased for manufactured goods as urban populations flourished and new technological advances in mining, metallurgy, and textile manufacturing generated new products. At the same time, the rise of the guild system and new financial tools used by commercial companies changed trade dynamics, making more goods available to an ever widening section of the society.[150] This great increase in productivity is, however, shadowed by a linked rise in levels of pollution. While people six centuries ago did not conceive industrial pollutants in the terms that we do today, no manuscripts speak of heavy metal poisoning, bacterial contamination, or carbon-dioxide emissions, this does not mean they were oblivious to these problems. Some of the dangers to people from crafts and guilds were recognized at the time, while others remained hidden.

Most industrial pollutants recognized during the period were viewed in terms of "miasma" and "bad air", which were perceived as the literal cause of illness. Thus, industries that let off foul odors were viewed with suspicion and kept at arm's length from the community. Tanners, for example, were notorious for the noxious fumes their work released, while dyeing, butchering, fish-processing, and the rendering of fats, could also be problematic. Due to the concerns about odiferous occupations, these activities in most towns were relegated away from the city center, or even outside its walls entirely, as was indeed the case in Krakow.[151] As pre-modern people

[150] Pavla Slavickowa and Zdenek Puchinger, Accounting Records of the Town Offices in Bohemia and Moravia: Methodology and Application in *Money and Finance in Central Europe During the Later Middle Ages*, ed. Roman Zaoral, (New York: Palgrave Macmillan, 2016) 153–202. Marian Małowist, "The Problem of the Inequality of Economic Development in Europe in the Later Middle Ages: Lecture, Oxford, 8.5.1965," *The Economic History Review* 19, no. 1 (1966): 15-28.

[151] Tanners had been forbidden to practice their trade within the city walls since time immemorial, and thus worked in the small suburb of *Cerdonia* (Garbory) located just beyond the (Szewska) gate on the east side of the city. Bieniarzówna and Małecki, *Dzieje Krakowa*, tom vol. 1, tom 1, 344. * Use English words to denote parts of a

had only their direct sensory experience to draw upon to tell them what represented a danger to health, they remained unaware of more subtle dangers. Air was thought to cause illness only if some foul odor could be detected while water contamination was obvious only if it could be seen or tasted. Imperceptible microbes, and the effects of heavy-metal bio-magnification would not be discovered for hundreds of years. Polluting effects from the dark underbelly of the metallurgic arts, so important to the growing Central European Economy, the secret leak of heavy metals from foundries, were not well understood.[152] Yet, while awareness was lacking of all the potentially detrimental results of local industries, people *were* conscious of many, and sought to limit their negative effects. This chapter looks at industrial pollution as it was present in medieval Krakow, how people at the time perceived it, and what efforts were made to manage it.

Industrial Pollution in Krakow

When seeking sites of pollution in Krakow, the first challenge is to identify what trades were practiced and where they were spread throughout the city. The formation of cooperatives of craftsmen in Krakow actually pre-dates the city's official foundation in 1257.[153] These craft groups in Krakow were granted a monopoly on production within the city and, unlike in many other cities, permitted to largely self-regulate their trade. The guilds flourished, and by the

~~publication, even if the original refers to it as Band, Teil, tomus, tome, etc. The most frequent abbreviations are: vol., pt., and bk for volume, part, and book, respectively). Use the English word closest to the original in meaning (E.g. Band = vol.; Teil = pt.)~~

[152] As analysis done at a metal workshop~~s~~ site~~s~~ in France has shown, even 800 years on, significant amounts of heavy metals could be detected in the soil. Baron, Carignan, and Ploquin, "Dispersion of Heavy Metals ~~(Metalloids) in Soils from 800-Year-Old Pollution (Mont-Lozère, France)~~," *Environ Sci Technol.* 2006 Sep 1;40(17), 5319.

[153] The foundation charter of the city, set down in 1257, granted special privileges to the butchers and the bakers along with the *calciparіorum,* who were recognized as already well-established groups. The first official guild statute issued however, would be granted to the *Kusznieny* (Furriers) only in 1377. *Kodeks dyplomatyczny miasta Krakowa 1257-1506* vol. 1 [Records of the City of Krakow 1257-1506], ed. Franciszek Piekosiński (Kraków: Akad. Umiejętności, 1879) n.r. 1-2. Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506* vol 2, n.r. 273.

mid-sixteenth century, the city had around 700 active workshops. Looking at the trades practiced in Krakow, there are four general categories of industry which would have been major potential polluters: the metallurgical arts, forms of tanning, meat processing, and textile manufacturing.

Having thus identified the crafts of interest, the next task is to pinpoint how they were dispersed around the city. Crafts in medieval cities were not evenly distributed, they tended to cluster by association, and thus carpenters' lane or smiths' streets were created. Trades which utilized water power naturally congregated along riverbanks, while craftsmen of luxury products tended to set themselves up near prestigious civic landmarks. An understanding of where each craft was located shows us the areas where pollution would have been strongly pervasive, and specific patterns of distribution may point to efforts to contain and manage it. Helpfully, in the case of Krakow, each of the city's bastion watch towers was left in the care of a particular guild to guard and protect, and that guild's workshops, logically, were often located close to their object of defense.[154] The map (fig. 23) of pollution zones throughout Krakow below, is based on information gleaned from civic records, recent archeological investigations, historical maps, old street names, and the defense duties prescribed for each guild.[155] The next section will focus on the noxious waste products produced by each of the aforementioned guilds, the impacts of these pollutants on Krakow city residents, and what methods if any were employed to curtail them.

[154] Józef, Muczkowski, "Dawne warownie krakowskie", [The defenses of Krakow]. *Rocznik Krakowski* 13 (1911): 1-48. accessed 4/10/2016, http://www.zwoje-scrolls.com/zwoje41/text15p.htm.

[155] It should always be kept in mind, however, that Krakow was never a static place. People moved, businesses closed, new ones opened, and change occurred. When businesses moved, their waste moved too. While the map I presented may have been true for a part of the city's history, it is but a glimpse.

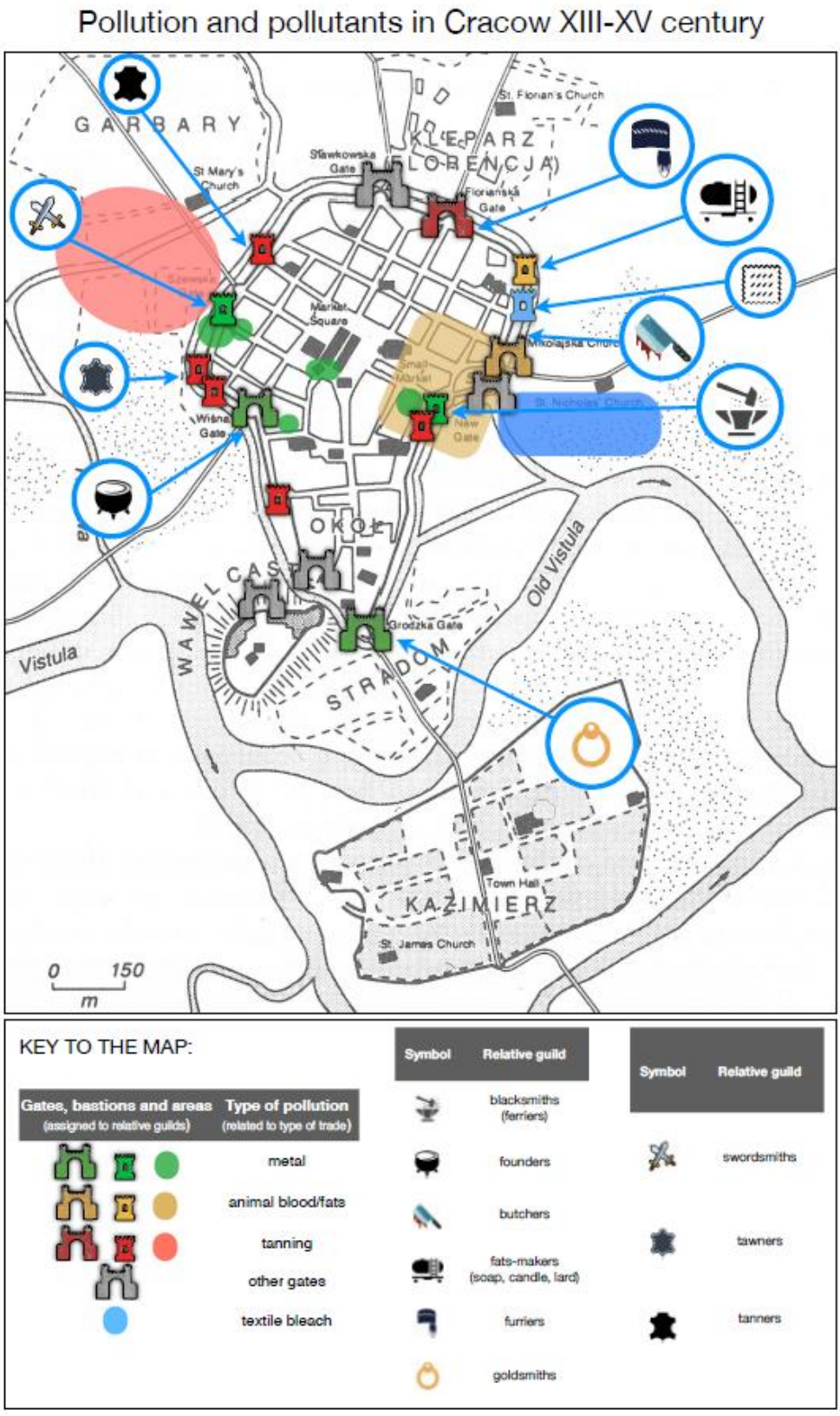


Figure 23: Map Showing Pollution Zones of Krakow's Guilds
(Map from Carter, Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 1795, 66) Markings by the Author and Karol Nowoszynski

Metallurgy

Founded upon rich local ore deposits, metallurgy was an extremely important industry in the areas of upper Germany, Silesia, and Greater Poland during the Middle Ages. Krakow merchants often acted as middlemen, exchanging Polish lead and salt for Hungarian iron, copper, silver, and gold. At times, they took a direct hand in the mining operations.[156] These metals, along with mercury and zinc, were the primary ones worked by craftsmen, and all of them offered some potential health hazards. Much of the initial, most polluting stages of metal processing were done on-site at the mine in order to reduce the cost of transporting useless material. However, contaminants were also released into the environment once they arrived in the city. Without full understanding of the insidious dangers of heavy metals whose ingestion is now known to be toxic, they were commonly used to make cookware, to glaze pots, and even given as medicine.[157] People thus came in contact with these objects every day and proudly brought out the pewter tableware to serve their friends.

Medieval Perception of Metallurgic Pollution

It is very hard to calculate precisely how metallurgic pollutants affected Krakow residents. There are no records of Krakow residents complaining of an acknowledged link between living downstream from the foundry and suffering the effects of metal poisoning. Still, there is evidence that medieval people were not unaware of the dangers of most heavy metals. Arsenic, of course, had long been a poison of choice for the diabolically minded, but as mining techniques became more advanced throughout the period, men could not help but notice the

[156]Danuta Molenda, "*Investments in Ore Mining in Poland from the 13th to the 17th Centuries*," *Journal of European Economic History* 5:1 (1976): 151–69.
[157] Philip Wexler, *History of toxicology and environmental health: toxicology in antiquity II*, (London: Academic Press, 2015), 6-10.

dangers vapors which arose in the mines and when minerals were worked in the forge.[158] The smiths and metalworkers, of course, were themselves the most affected by these pollutants. Evidence suggests, however, that they were not completely unaware of these occupational hazards. [159] Miners and smiths were encouraged to wear gloves when working with "poisonous

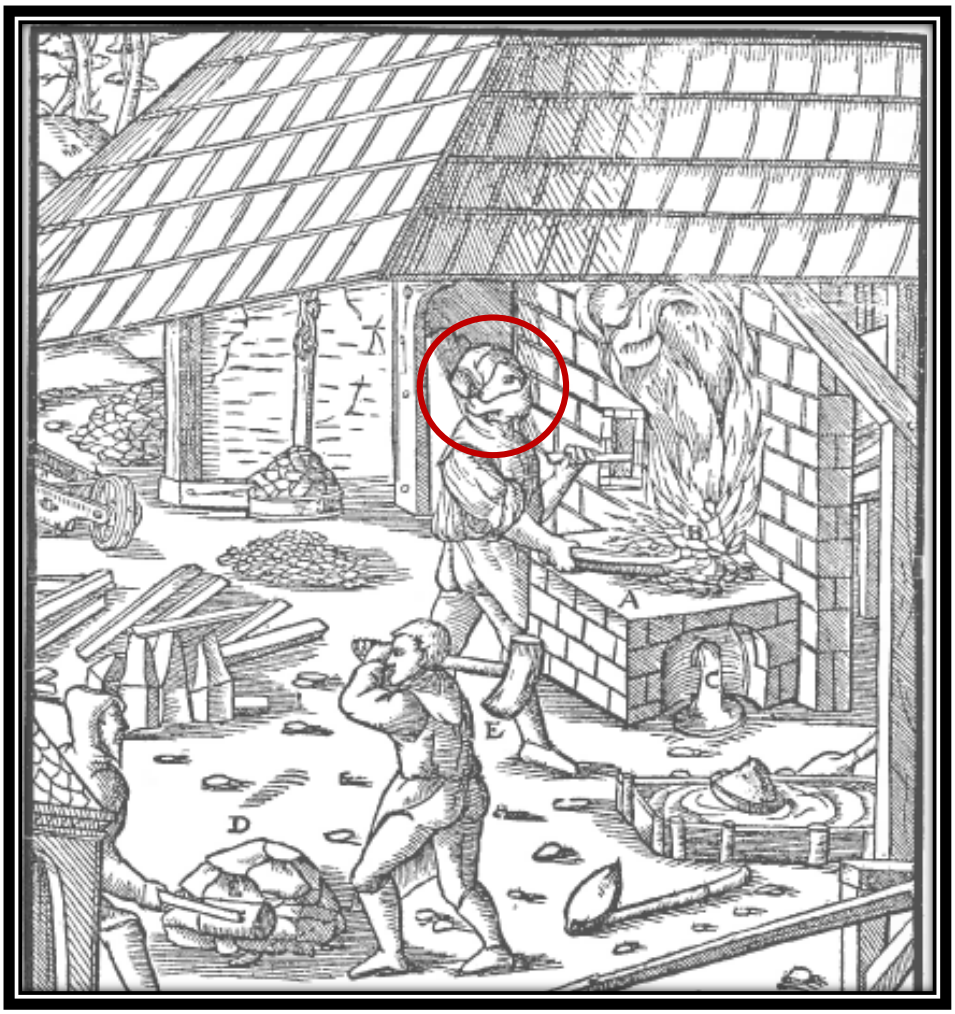


Figure 24: A smith covering his mouth and nose to protect himself from "Dangerous Vapors"

Detail from the De re metalica (Agricola, De re metalica, 422)

metals" and to cover their faces with veils (Fig. 24) to protect against dangerous vapors.[160]

[158] For the use and abuse of Arsenic and its effects during the Middle ages see William T. Frankenberger, *Environmental Chemistry of Arsenic* (New York: Marcel Dekker, 2002), 8. .

[159] Book 1 of the De Rre mMetallica, raises and then discards one by one different charges brought against the art of metallurgy including discussion of its negative environmental impact and polluting possibilities. See: Geor Agricola, De Rre mMetallica. Herbert Hoover, and Lou Henry Hoover ed. (New York: Dover Publications, 1950), 8-9.

[160] For example, Johann Mathesius in a short treatise on mining, *Sarepta Oder Bergpostil* published in Nuremberg in 1562 wrote that, "After quicksilver [mercury], and *rotgultigen* ore, are cobalt and *wismuth* fumes; these are the

How well methods to avoid these dangers worked, is of course another question. The handbook of German metallurgy, the *De re metallica* published in 1556, recorded that hungry smiths would often eat butter, "that the poison which the crucible exhales may not harm him,"[161] a remedy modern science would tend to question. Yet, even as the smith sought to protect himself by eating butter, he undermined his cause by doing so off of pewter plates. Worked objects were deemed perfectly safe, as the perceived dangers of metallurgy do not appear to have extended beyond harmful vapors. This was a simple extension of the medical wisdom of the day. Without a greater awareness of leaching metal contamination, finished objects like plates or pottery, continued to be used.

Modern Assessment of Medieval Metallurgic Pollution

Although people would have been largely unaware of it at the time, the level of poisoning would have depended greatly on one's proximity to metalworking sites. Plants in gardens growing near smithies in contaminated ground would soak up the heavy metals, as would animals grazing on those plants, passing them along to humans in each succulent bite.[162] Heavy metals could also seep into the water supply -- local streams and the wells that residents drew their drinking water from. The large amounts of smoke produced from the charcoal forges that allowed smiths to form and craft these metals, also spread poison throughout the town. Recent studies have found heavy metals present in human bones from the late medieval period across Europe to be an order of magnitude higher in concentration, compared with the previous

most poisonous of metals" and that they "kill many mining people and those that work people who do much work among the fumes of the smelters." To protect against these dangers he suggested the wearing of heavy leather gloves and veils over the face to avoid breathing in its dust. Quoted in Agricola, *De re metallica*, 214, note 21.

[161] The De re metallica also includes five pages dedicated to the dangers of mining and metalworking. See: Ibid. 214-18, 474.

[162] This problem of biomagnification would have been significant as farming and agricultural activities continued to be practiced within the city walls throughout the medieval period. Mueller-Bieniek, "Cultivated Plants in Medieval Kraków…", 97–114

Roman, early medieval period, and our modern day.[163] While I am aware of no study done on the bones of former Krakow residents searching for signs of heavy metal poisoning, given results from studies completed in similar urban circumstances, it seems likely that a significant portion of the population was affected. By the fourteenth century in Krakow, metals were being worked in three phases. Every step along the way released some type of polluting waste into the local environment in the form of slag, cinder, and heavy metal leaching. Very little thought was put into the ramifications such methods would have.[164]

In the first stage, metal ores of copper, iron, and lead were sorted and then treated onsite at the mines from which they were extracted.[165] This initial smelting process released a host of pollutants, including sulfur-dioxide gas, lead, and arsenic. Arsenic, which would increase cancer rates in both humans and animals grazing near smelting sites, was a particularly wide-spread and treacherous problem, as it occurred in conjunction with most polymetallic ores across Europe. This problem included the lead, silver, and copper mines in Slovak Upper Hungary, which came to be controlled by the Krakow burghers, Johann Thurzo and Jakob Fugger.[166] Unaware of these risks, few precautions were taken. Luckily for the citizens of

[163] While the main body of the article is focused on observations in France, other finds showing the same late-medieval spike in Pb concentration for the rest of Europe, including Poland, are presented in Jaworowski et al., "Heavy Metals in Human and Animal Bones from Ancient and Contemporary France," 119–20. Work done by archeologists comparing lead and mercury exposure in urban and rural populations in northern Germany and southern Denmark has also revealed results that firstly, Pb and Hg were more present in urban populations than in rural ones (although about 35% of the rural population was also showed signs of high lead levels), and that Pb within the urban population was significantly higher in the individuals tested from a cemetery active during a later period between1350-1536 than those buried between 1069-1250. Rasmussen et al., "Comparison of Mercury and Lead Levels in the Bones of Rural and Urban Populations in Southern Denmark and Northern Germany during the Middle Ages," *Journal of Archaeological Science*: *Reports*, 3, (2015): 367.

[164] The De re metallica does address some of these concerns but dismisses them as necessary evils. Agricola, *De re metallica*, book 1.

[165] Carter, *Trade and Urban Development in Poland*, 115. In the case of iron, the smelting process produced "cast iron" which due to its brittle nature once cooled had to be worked further to produce wrought iron. Shaft furnaces (common in the mines supplying Krakow) produced pig iron which was not as immediately workable as bloomery iron but could be forged more quickly in larger volumes. Still, shaft furnaces were incomparably less efficient than the blast furnaces which would come to replace them in the fifteenth century. Mihok, Moravčíková, and Petrík, "Charcoal Blast Furnaces on the Territory of Slovakia," *Materials Science (Medziagotyra)* 11, no. 4 (2005): 324.

[166] Although it is impossible to say now if cancer rates were higher among those who sent metals to Krakow, reports of high rates of cancer among those who worked near smelting facilities and among animals who grazed

Krakow, the location of the Upper Hungarian-Slovak mines was surrounded by ample forests, which allowed for the extracted ore to be processed on-site and thus Krakow avoided the polluting effects. After this first smelting stage, the ingots or "pigs" produced were then transported to Krakow via ship, or overland in

carts, once in the city taken to the *Rynek* where they were weighed, assayed for taxes, and then purchased by local craftsmen or sold onwards by merchants. Once metal craftsmen had

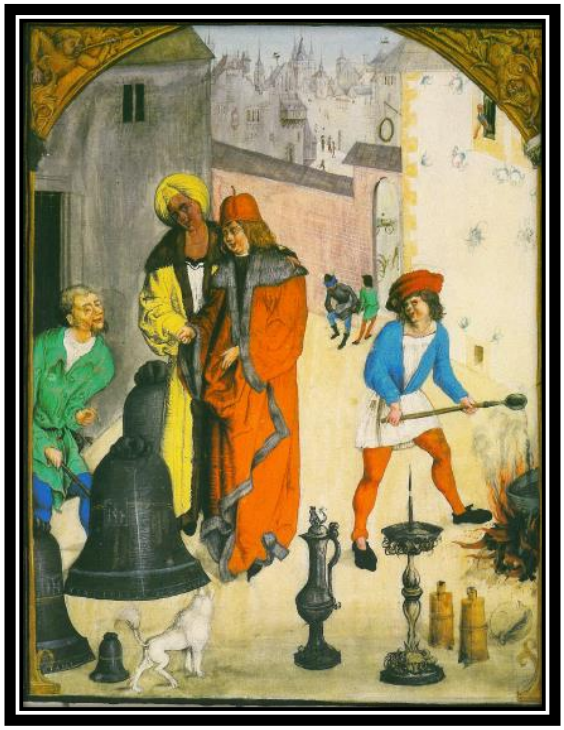


Figure 25: The Odlewni (Founders) Dzwoniarze (Bell makers) Guilds
(Balthasar Behem Codex 1505 Folio 281)

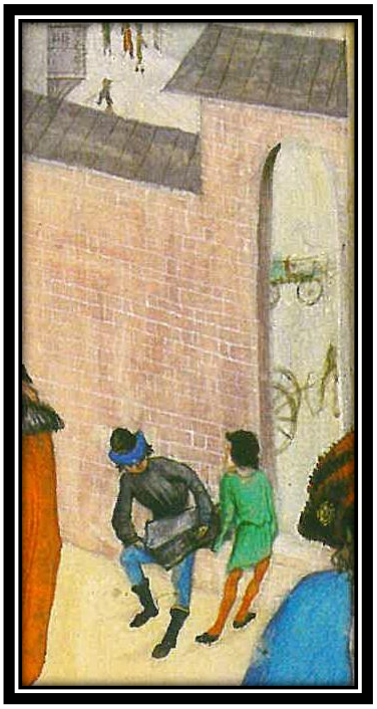


Figure 26: Detail of Men Hauling Ore
(Balthasar Behem Codex The Odlewni (Founders) Dzwoniarze (Bell makers) Guilds 1505 Folio 281)

purchased their refined materials in the marketplace, they carried them back to their workshops and fired up their forges (Figs. 25/26).

During the fourteenth and fifteenth centuries, Krakow had a large number of different metal-crafting trades. Those mentioned in the 1505 Behem Codex[167] were the: *Złotnicy*[168]

near such foundries, are well documented from the nineteenth century. Frankenberger, *Environmental chemistry of arsenic*, 8.

[167]Baltazar Behem, *Codex picturatus Balthasaris Behem: facsimile.* (Cracow: Krajowa Agencja Wydawnicza, 1988).

[168] While the extraction of silver and gold was a highly polluting process, the small amounts of metal *Złotnicy* worked with meant they were not significant polluters within the city. The one point where contamination might

(Goldsmiths). *Odlewni*[169] (Founders), *Dzwoniarze*[170] (Bell founders, a composite guild, which also included tin-smiths, and cauldron makers), *Miecznicy* (knife and sword-makers), *Iglarze* (Needle-makers), *Kowale* (Blacksmiths, another combined guild) and the *Konowały* (Ferriers). Archeological investigation of heavy metal residue found that sites all over the city where craft shops must have been located were contaminated to various degrees.[171] These guilds worked with many different types of metal, including: gold, silver, zinc, tin, iron, lead, copper, and combinations thereof. Of these, we now recognize copper and lead as the two most potentially problematic metals worked within the walls of Krakow.[172]

The fact that these shops were not subject to the zoning restrictions common to other polities, allowed this pollution to contaminate every quarter of the city. This is evidenced by recent archeological investigation and chemical analysis of medieval soil samples which showed widespread high concentrations of both copper and lead.[173] (Fig. 27) Lead contamination in

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have occurred inside Krakow would be during 'cupellation", a process whereby gold and silver could be further refined and separated from any other base metal. This process could release some lead. For more on the art and chemistry of goldsmithing, see: John Cherry, *Goldsmiths*, (London: British Museum Press, 1992).

[169] The *Odlewni* (founders) Guild, used lead combined with tin became pewter which was cast into plates, candlesticks, drinking mugs, buckles, pots, and even pilgrim badges and for lining chamber pots to make them less porous. Much of this work was actually bronze, an alloy of around 88% copper and 12% tin often mixed with small amounts of additional materials. Ronald F. Homer, "Tin Lead and Pewter," in *English Medieval Industries*, John Blair and Nigel Ramsay (London: The Hambledon Press, 1991) 57-80. Johan J. Mattelaer, "Some Historical Aspects of Urinals and Urine Receptacles," *World Journal of Urology* 17, no. 3 (1999): 145.

[170] Krakow was famous for its bell makers, who performed this particularly difficult type of casting. Bell metal has a higher ratio of tin to copper than bronze, 22% tin and 78% copper by mass. "Bell Metal: Materials for Functional Bells," accessed 22/02/2016 http://www.historyofbells.com/bell-making/bell-metal/

[171] Maciej Pawlikowski, Marta Wardas, and Joanna Such, "The Investigation of Geoarchaeological Layers of Krakow City, Poland," in *Geoarchaeology and Archaeomineralogy: Proceedings of the International Conference, 29-30 October 2008; Sofia*, ed. R. I. Kostov, B. Gaydarska, M. Gurova, (Sofia: St Ivan Rilski, 2008), 280.

[172] Iron, tin, and zinc pose health hazards only if ingested in large quantities, while lead and copper are potentially toxic even in relatively small amounts, and can constitute a significant threat with prolonged exposure. As an example, once in the body, copper settles in the liver causing damage with other common symptoms including abdominal pain, vomiting, diarrhea, a metallic taste in the mouth, and with acute toxicity, convulsions, paralysis, coma, and death. Lead is potentially even more problematic and could cause neurological dysfunction in children, as well as other symptoms including nausea, abdominal pain, diarrhea**,** muscular weakness, even paralysis of the limbs, severe anemia, and palsy. Robert Alan Lewis, *Lewis' Dictionary of Toxicology* (Boca Raton Fla: CRC Press, 1998), 311, 620, 647-8, 1126. Steve Blunden, and Tony Wallace, "Tin in Canned Food: A Review and Understanding of Occurrence and Effect," *Food and Chemical Toxicology* 41, no. 12 (2003): Pages 1651–62. Herbert L. Needleman, *Human Lead Exposure* (Boca Raton, CRC Press, 1991).

[173] In Siena for example, a local blacksmith was forced to move two streets over as his house was mowed down in a communal street re-alignment project and prevented from re-colonizing in that zone because his activities were seen to be noxious, bad for public health, or simply unbecoming of the dignity of the town. The city fathers went

the Krakow environment was a particular problem, as it was used in such a wide variety of objects everything from dishes to roof-tiles (which might taint the drinking water as roof run-off, as records show was collected and stored by residents in wooden barrels).[174]

The work of the guilds within the city, combined with the nearby building of such massive copper smelting works as that inaugurated by the enterprising Krakow burgher Jan Thurzo in 1490, were not good for the local water or food supply.[175] The nearby smelters were described as, "looking like Mt. Etna, with furnaces burning full of [metals]…being joined by fire." Smoke discharged from forge chimneys released not only soot and carbon dioxide but also, "integrated materials from smoke-fallout," which might include particles of: lead, copper, antimony, arsenic, and zinc, all of which can be harmful to human health.[176] These soot particles, landing in farmlands and pastures tainted the food supply allowing levels to build up in people to the point they became toxic.[177] As the city government appears to have been unaware of the dangers of most of these processes, very little was done to manage its effects and the impact of the working of these metals came to have ramifications reaching far beyond the city itself.

on to legislate a number of these "delimitato" zones in the following years in 1218, 1246, and 1249. Thomas Szabo, "Visualizzazioni del potere a Siena e in altre città comunali (secoli XII-XIV)," in *Siena e Maremma Nel Medioevo* (Siena: Betti Editrice, 2001), 237-338.

[174]Lead was also common in glazes for ceramics, making them dangerous if they stored food. Otherwise Lead was used, "either in the pure form for domestic utensils, church ornaments and church roofing, or mixed with other metals to make armor, trappings for horses, chains for livestock and prisoners, candlesticks, arms, etc." Carter, *Trade and Urban Development in Poland*, 110. "The sources for Pb in the medieval societies encompassed lead glazed ceramics which were in close and daily contact with foodstuff; lead containing coins; stained glass windows; lead tiled roofs which were in some instances in contact with the drinking water." Rasmussen et al., "Comparison of Mercury and Lead Levels in the Bones of Rural and Urban Populations in Southern Denmark and Northern Germany during the Middle Ages," *Journal of Archaeological Science: Reports* 3 (2015): 359. For evidence of water barrels see: Cembrzyński, *Zaopatrzenie w wode...*,17.

[175] The copper-smelting facility opened in 1490 in the village of Moglia just outside Krakow. Paul Knoll, Urban development of Medieval Poland in *The Urban Society of Eastern Europe in Premodern Times*, Bariša Krekić ed., 95 Carter, *Trade and Urban Development in Poland*, 117.

[176] S. Baron, J. Carignan, and A. Ploquin, "Dispersion of Heavy Metals… ," 5322.

[177] Sheep and grazing animals are especially prone to the biomagnification process whereby small levels of contaminates in plants are concentrated the further they move up the food chain. Lewis, *Lewis' Dictionary of Toxicology*, 311. "Copper: Nutritional Disorders," *MSD Manual Professional Edition*, accessed February 13, 2016, https://www.msdmanuals.com/professional/nutritional-disorders/mineral-deficiency-and-toxicity/copper.

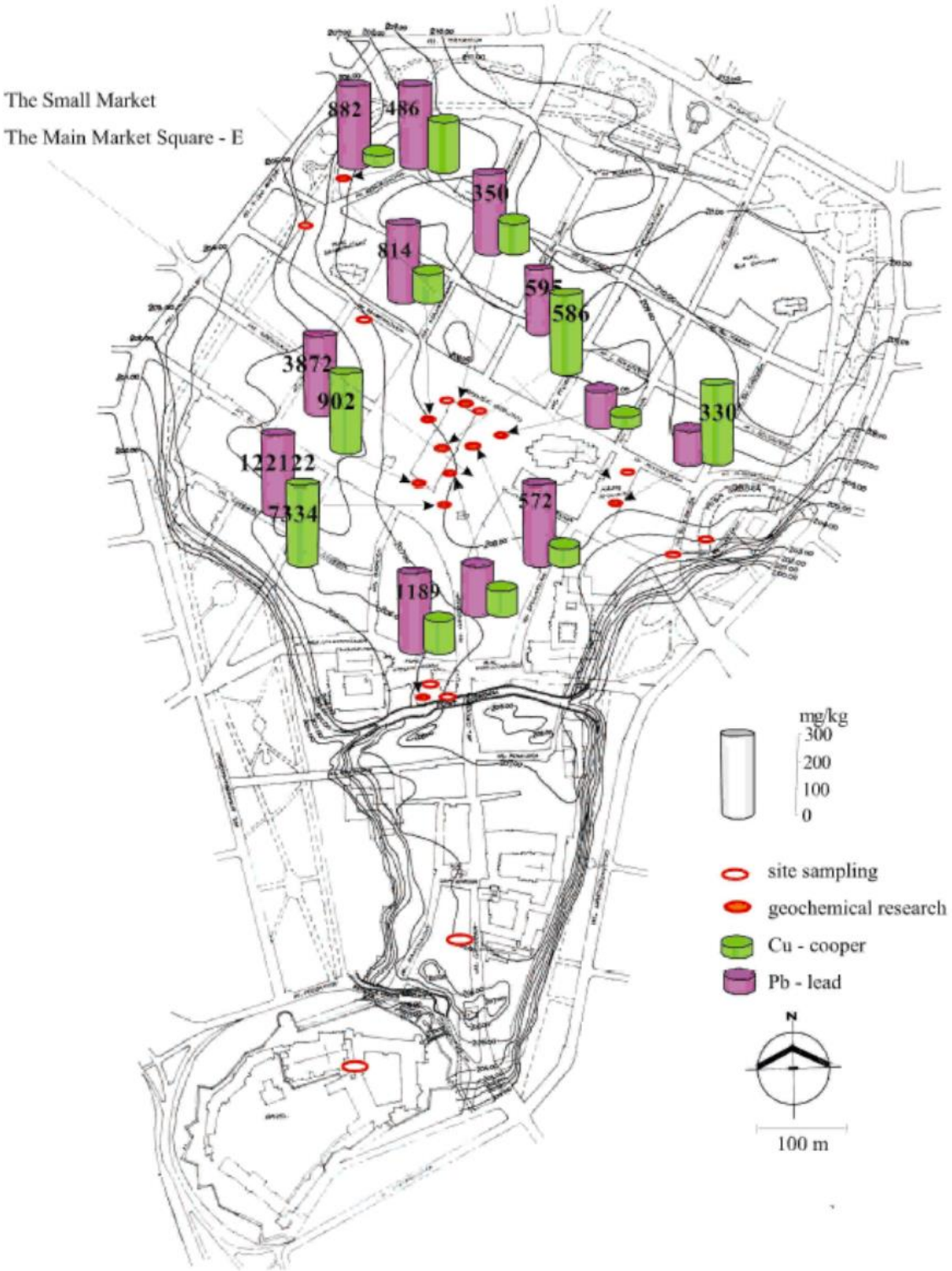

Figure 27: Map of sampling sites and copper and lead concentrations in soil samples reflecting Krakow's medieval period

(Image reproduced from ~~(~~Pawlikowski, ~~,~~"The Investigation of Geoarchaeological Layers of Krakow City, Poland," 2008~~,~~ 280.~~)~~)

The Wider Ramifications of Krakow's Medieval Industrial Pollution

The smelting and smithing done in Krakow contributed to~~to~~ wide-scale atmospheric pollution as has been recently assessed by ~~researcher in Sweden~~Maja-Lena Brännvall's team. Through their analysis of peat-cores, the researchers determined that at the start of the Middle Ages, "there was a conspicuous, permanent increase in atmospheric lead pollution fallout."[178] This "fallout" peaked in 1200 and again in 1530 at levels comparable to today's modern industrial output. As the researchers noted, these historic high points, "match the history of metal production in Europe…and "indicates that the contemporary atmospheric pollution climate in northern Europe was established in medieval time, rather than in the Industrial period."[179] The ecological disaster zone known as the Błedów ~~Below~~ Desert (Fig. 28), was also created to feed

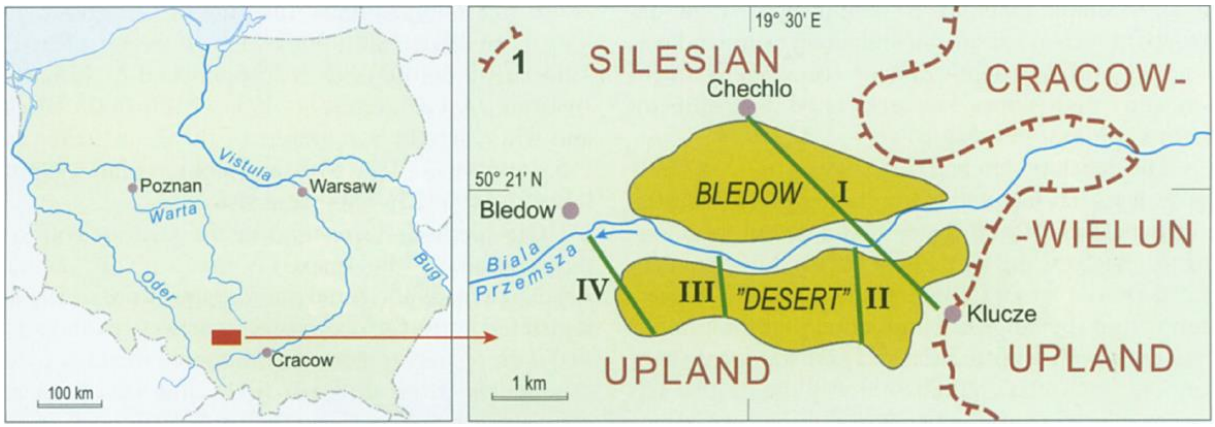

Figure 28: Map showing the location of the Błedów ~~Below~~ Desert
(Rahmonov "Vegetation Succession over and Area of a Medieval Ecological Disaster: The Case of the Błedów Desert, Poland," 244)

the

[178]Such atmospheric lead pollution affects delicate ecosystems in the high arctic by causing water acidification in Northern lakes. Brännvall et al., "The Medieval Metal Industry Was the Cradle of Modern Large-Scale Atmospheric Lead Pollution in Northern Europe," 4391.~~Maja-Lena Brännvall et al., "The Medieval Metal Industry Was the Cradle of Modern Large-Scale Atmospheric Lead Pollution in Northern Europe," *Environmental Science & Technology* 33, no. 24 (1999): 4391.~~

[179] Ibid.

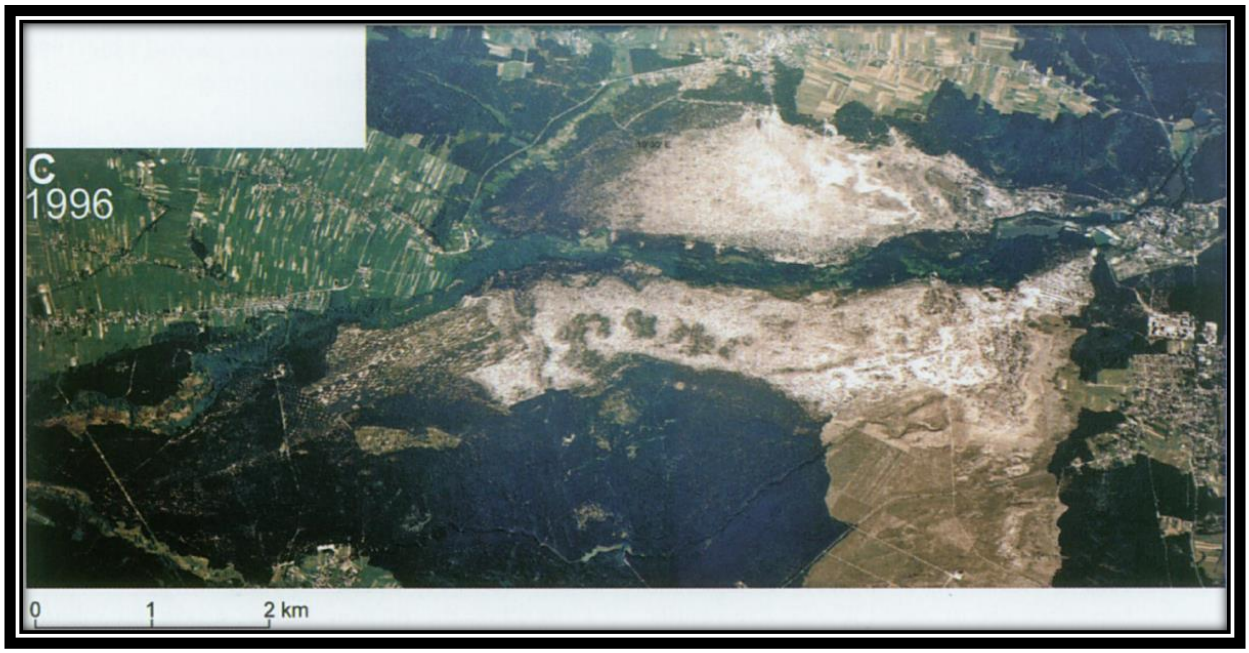

Figure 29: Aerial photograph of the Błedów ~~Below~~ Desert as of 1996
(Rahmonov, "Vegetation Succession over and Area of a Medieval Ecological Disaster: The Case of the Błedów Desert, Poland," 246)

Figure 30: Błedów ~~Below~~ Desert 2014
(Wikimedia Commons: https://en.wikipedia.org/wiki/B%C5%82%C4%99d%C3%B3w_Desert#/media/File:Pustynia_B%C5%82%C4%99dowska_061914.jpg)

needs of Krakow's metallurgic ambitions. Located not far from Krakow, the vast expanse of blowing sand and gravel which covered 34 square kilometers was created by clear-cut logging

done during the Middle Ages leading to soil degradation and eventually desertification. [180] The logging was done in order to sustain the mines, and to create charcoal to fuel the furnaces of the metal smiths.[181] To this day the area has yet to recover (Figs. 29/30). While the municipal government of Krakow cannot fairly be blamed for this calamity which stretched beyond their jurisdiction, it is clear that the success of the city's metal guilds, and most medieval industries in fact, were built on the back of clearly unsustainable environmental practice.

[180] Oimahmad Rahmonov and Wojciech Oleś, "Vegetation Succession over and Area of a Medieval Ecological Disaster: The Case of the Błedów Desert, Poland~~VEGETATION SUCCESSION OVER AN AREA OF A MEDIEVAL ECOLOGICAL DISASTER. THE CASE OF THE BŁĘDÓW DESERT, POLAND~~," *Erdkunde* 64, no. 3 (2010): 245.

[181] The extent of the devastation is unsurprising as it is estimated that to obtain 50 kilograms of iron, 25 cubic meters of wood had to be burned, meaning that a single smelting furnace to consume a kilometer of forest every 40 days Mines bringing metal to the surface ~~too~~ ate up forests as they were used for supports and beams. Charcoal is produced through the burning of wood in a low oxygen environment. This produced a fuel with could burn at a higher temperature than normal wood. However, it takes 2-3 times as much wood to produce a single unit of charcoal and so vast amounts were burned. This process not only devastated forests but also released large amounts of carbon dioxide ~~gas~~. Ibid. Jean Gimpel, *The Medieval Machine: The Industrial Revolution of the Middle Ages*,(London: Pilico, 1992),79.

Figure 31: The Wielka Waga Miejeska in the Rynek as it looked in the seventeenth century (Reconstruction by the Muzeum Historyczne Miasta Krakowa http://www.modnykrakow.pl/?p=18570)

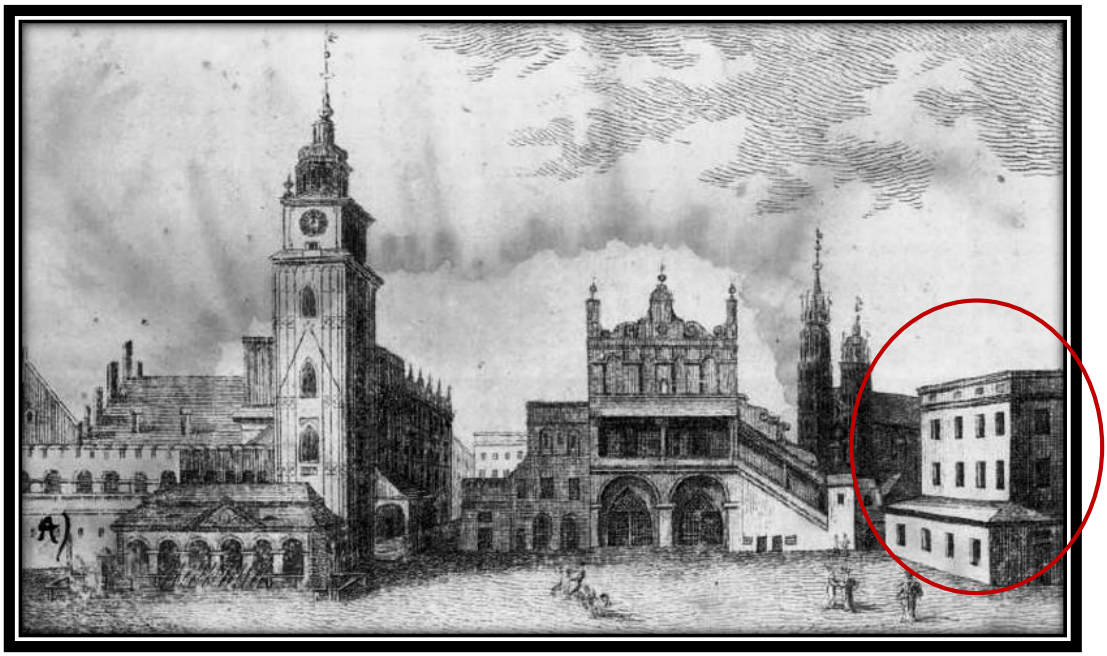

Figure 32 The *Wielka Waga Miejeska* of Krakow as it looked in 1827
(Łukasz Kozakiewicz http://www.starykrakow.com.pl/dawny-rynek/rynek.htm)

The city's management of metallurgic activities was driven by two primary concerns neither of them related to health or environmental degradation the long term ramifications of which they appear to have been almost completely unaware.[182] Rather, the city governmental authorities cared about the metal trades' impact on the economy and possible disputes between smiths and their neighbors. Krakow itself, was a great trade emporia for metal goods. Having its own natural resources of lead, and as a mid-way point between the mines of Hungary and the metal lands to the west, the city was in a very good position to turn huge profits in the metals trade. Cartloads of copper and iron headed west while lead was sent south as silver and gold flowed towards the Wawel and the royal court.[183] The profits to be gained from metal production meant that the city had a vested economic interest in controlling it. From the time of Casimir the Great (r. 1333-1370), many civic statutes were issued in an attempt to better regulate the trade in raw materials. The *Wielka Waga Miejeska* (The Great Weigh House) (Figs. 31/32), located on the southeastern side of the *Rynek* between the *Sukiennice* (Cloth Hall) and the Church of St. Adalbert, is thought to have been first installed at this time.[184] The weigh house was equipped with an enormous set of scales where materials were measured against weights of set value ensured by the city.[185]

[182] Even if the smith's themselves were at least partially aware of the some of the dangers of their trade – the city counselors as a body were not or did not consider the dangers a significant threat.

[183]In 1306, Krakow gained the special privilege of a stapling right on copper and thus throughout the next two centuries, dominated the lucrative copper trade between Hungary and the West, and becoming known as, *ein Kupfer-Haus* amongst the cities of the Hanseatic league. Carter, *Trade and Urban Development in Poland*, 109–16. Garbacz-Klempka, "Metallurgy of Copper," 282.

[184]However, the earliest reference to a simple weighbridge in the city comes from 1302, and refers to the measuring of lead. Garbacz-Klempka and Rzadkosz, "Metallurgy of Copper,"Archives of Metallurgy and Materials 54 (2), 283; Garbacz-Klempka and Szucki, "Computer Modelling in Visualisation and Reconstruction of Archeological Relicts," *Archives of Metallurgy and Materials* 54, no. 2 (2009), 340.

[185]This was done in order to insure fair dealing and as a means to assess tax dues. Merchants were required to bring their loads of ore to the weigh house and have them checked before sale. Further refining of the raw materials was also done here and the materials sold to local craftsmen. Garbacz-Klempka, "Metallurgy of Copper," 283. Garbacz-Klempka and Szucki, "Computer Modelling in Visualisation and Reconstruction of Archeological Relicts," 341.

The metals bought by locals that required further refining were re-heated in a finery forge on the market square, wrought into a malleable form and then sold.[186] From the year 1358, all such refining of precious metals, be it silver or gold, was required to be done in the *Rynek*. Only for a fee were craftsmen permitted to melt their materials to a useful state under the watchful eye of city weight inspectors.[187] This monopoly on the melting of silver and gold remained a steady source of income for the municipal government throughout the following centurie. While the authorities implemented these measures in order to control the metal trade for economic reasons with no regard for the industries polluting consequences; the policy of forcing craftsmen to further refine materials in the public eye of the main square did, however, have the unintended effect of quarantining the worst of the heavy metal pollution within the city to the area surrounding the *Wielka Waga Miejeska*, as chemical analysis of soil in the area confirms.[188] In this way, the municipal authorities might be said to have managed pollution levels from metalworking but only by happy accident.

The fact that the metal craftsmen were not compelled by the authorities to congregate in a specific part of the city or beyond its walls entirely as we shall see was required of the tanners, is a bit surprising. Other cities put tight controls on where such craftsmen could operate. Siena for example, banned blacksmiths shops within a two block radius of any major civic site.[189] Such regulations might be expected as, it could not have been easy, living next to such workshops. A section from an anonymous poem entitled, *A Poet's Complaint of the*

[186] The precise nature of the forge used on the market square is debated and likely changed over-time. For more on the technology of medieval furnaces see: Norman John Greville Pounds, *An Economic History of Medieval Europe* (London: Longman, 1974), 322–27.

[187] Piekosiński, *Kodeks Dyplomatyczny Miasta Krakowa 1257-1506* vol. 1, nr. 32.

[188] Lead and copper levels in the soil at the sight of the former weigh house were by far the highest of any other site tested. Pawlikowski, "The Investigation of Geoarchaeological Layers of Krakow City, Poland," 280.

[189] In Siena for example, The local blacksmith was forced to move two streets over as his house was mowed down in a communal street re-alignment project and prevented from re-colonizing in that zone because his activities were seen to be noxious, bad for public health, or simply unbecoming of the dignity of the town. Siena legislated a number of these "delimitato" zones in the years 1218, 1246, and 1249. Szabo, "Visualizzazioni del potere a Siena e in altre città comunali (secoli XII-XIV)," in *Siena e Maremma Nel Medioevo*, Maria Aserchi ed. (Siena: Betti Editrice, 2001), 237-338.

Blacksmiths, written in the fourteenth century, gives a vivid description of what it might have been like.

> Swart smutted smiths, smattered with smoke,
> Drive me to death with din of their dints;
> Such noise on nights ne heard men never.
> What with knaven cry and clattering of knocks! [190]

Few indeed would wish to have such neighbors. Things may not have been all as bad as they first appear however. Looking at the images presented in the Behem codex, it would appear that most potentially troubling industrial sites were not located right next to domestic household but were at least some ways distant and enclosed within their own courtyards. The images of bell founders, potters, and tanners, all show work sites separated from the rest of the city by a wall enclosing large open courtyards and craft buildings. However, at a later date, record of a complaint made by a Krakow resident against a coppersmith his neighbor tired of the enormous racket coming from a "huge chimney with two bellows, and anvils in front," shows that problems still arose.[191] The Krakow house owner had a right to complain against his smithing neighbor as the only legislation regulating smithies related to the building of chimneys.

Two types of legislation regulated the metallurgic guilds in Krakow, those concerned with trade discussed above and those that came from Magdeburg law and covered the proper construction of ovens which might be extended to include forges and chimneys. This law read, "The oven…shall be three feet distant from the fence. Each man shall maintain his oven walls so that sparks do not fly into another man's yard and cause harm."[192] Here we see that again as

[190] Gimpel, *The Medieval Machine*, 84–5.
[191] Kamila Follprecht, "Buildings and Dwellings of Krakow in XVI-XVII Century: Descriptions contained in the City Deeds," *Geology, Geophysics and Environment* 40, no. 2 (June 30, 2014): 185–6.
[192] Eike von Repgow, *The Saxon Mirror*, trans. Maria Dobozy, (Philidelphia: University of Pennsy;vania Press, 1999), Book 2, 108, no. 51.

with the latrines and water canal regulations, waste is not what concerns of the municipality but rather the protection of private property from potential damage, here from fire rather than water. Thus, if one is very broad with definitions, it could be said that Krakow's leaders sought to manage the metallurgic crafts through fire-safety measures. But even this stretching things as the law applied to all citizens and was not directed specifically at the guilds. [193]

Tanning

Tanning and furring were another set of highly polluting industries that had been important in Krakow from an early period. Indeed, it was the *Kuśnierzy* (Furriers Guild), who received the city's first official guild charter in 1377. [194] Given that one of the Polish kingdom's great resources was furs and hides taken from animals who lived in its vast forests, this is not surprising. Leather was in high demand as many everyday articles were made from it including shoes, horse-reigns, straps, gloves, bags, saddles, and parchment, even window coverings, along with a host of other items.[195] These leather and firs produced in Krakow were used to meet domestic demand but were also exported to markets in the West and to the South.[196] The tanning process, however, was notorious for being a messy, stinking, dirty business that often involved putrefying flesh, harsh chemical additives, and a great deal of water. The fine leathers produced through these processes were greatly prized but the work done to create them, and by extension the workers themselves were viewed negatively.[197] This relative low-status despite

[193] All citizens were charged with ensuring fire safety throughout the town and to aid in the event of a blaze. To encourage such civic duty, the city issued a reward to the first three people person to arrive at the scene of a fire with a full barrel of water. Despite these measures, Krakow suffered from significant damage from fires that raged through the town in 1455, 1477 and 1494. Kutrzeba, *Finanse Krakowa w wiekach średnich,* 42.

[194] Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506,* vol. 1, no. 385.

[195] Before the widespread use of glass, windows were often covered in a fine skin membrane or parchment to let in some light but keep out the elements. Jan Patasnik "Towns in Medieval Poland," in *Polish Civilization,* ed. Mieczysaw Giergielewicz, and Ludvik Krzyzanowski (New York: New York University Press, 1979), 44.

[196] Carter, *Trade and Urban Development in Poland,* 127.

[197] As is true in many cultures around the globe, tanners in medieval Europe did not have a high status, although they assuredly did not suffer as much discrimination as the Burakumin of Japan or the Dalit and Chamar "untouchables" of India.

the trades' profitability related directly to its highly polluting nature, both practical and symbolic. Tanning, produced tangible bad smelling eluents and because it dealt with dead things was pregnant with negative symbolic associations. Tanning waste was recognized as an obvious social evil by medieval people, unlike that of metallurgic crafts, and thus some efforts were made to manage it by municipal authorities. In Krakow, this manifested in the tanners having been banned from time immemorial from performing their craft inside the city proper and the zoning of their activities to an outlying suburb. (Fig. 34).[198] Early in the guilds' history, the tanners were subdivided into two main branches, the "red tanners" and the "white tanners". Red tanners produced true leather, strong supple material nearly impervious to water or decay but whose creation was highly polluting. White tanners, on the other did hand, not truly "tan" their hides. Instead, they used a somewhat less noxious method known as tawning to produce a soft, white, supple material, similar to the way the furriers preserved their skins.

Red and White Tanners

The true or "red" tanning of a hide was an intense multi-stage process that could take up to two years to complete. Hides would be purchased by tanners in Krakow, fresh from local butchers or in a salted state from merchants.[199] Once acquired, the skins would be taken outside the city walls to the suburban work area known as Garbary after the *garbarnicy* (tanners) which was located just northwest of the city beyond the *Stawkowska* (Tailors's Gate). Here, along the banks of the Rudawa, they went about their work. First, the skins would then be washed in the river to remove any lingering blood, dung or salt used to preserve the hide. This action was the first, but not the last which polluted the river's water.[200] The next step of de-hairing also

[198] Bieniarzówna *Dzieje Krakowa* vol. 1, 344–45.
[199] Tanners worked primarily with the skins of domestic animals, cows, goats, sheep, ox and pigs, but also deer.
[200] For information on methods of Tanning and its polluting effects see: Cameron and Archaeological Leather Group, *Leather and Fur*; Mazumder, Biswas, and Bandyopadhyay, "Study on Leaching of Pollutants from Vegetable Tanning Residue"; Mwinyihija, "Main Pollutants and Environmental Impacts of the Tanning Industry"; Jørgensen, "Local Government Responses to Urban River Pollution in Late Medieval England;" John Cherry,

impacted water quality as hides were either left until natural putrefaction at the root of the hair caused it to loosen, or the hides were left to soak in pits or wooden tubs in a strongly alkaline liquor made from wood ash or slaked lime which quickened the process but released potentially dangerous Hydrogen Sulphide gas with its recognizable sulfuric stench.[201] Both processes smelled horrible and the lime baths were later dumped along with the hair that was scraped off

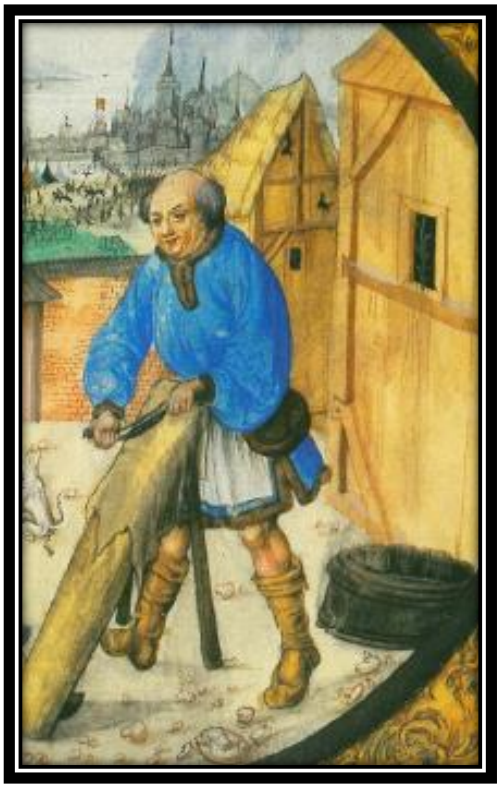

Figure 33: Image of a KrakowTanner scraping a hide with a soaking tub set beside him.
(Balthasar Behem Codex, Guild of the Garbaze (Tanners) Folio 276)

with a special skinners' knife (Fig. 33) further contaminating the Rudawa. After the lime bath yet another smelly stage was necessary as hides were de-limed by being rubbed or soaked in a bath of alkaline bating composed of bird guano or dog dung. Indeed, in Krakow dog dung was purchased directly from the royal kennels.[202] Hides might also go through a "drenching process", suspended in a rye or barley mush bath mixed with urine. Indeed, for the tanners, one

"Leather" in *English Medieval Industries*, John Blair and Nigel Ramsay (London: The Hambledon Press, 1991) 215-318.

[201]In high doses, the gas can cause hypoxia as it prevents enough oxygen from reaching the brain but it would be very difficult for such large doses to accumulate in the opening medieval tanning yard. However, long-term exposure at more moderate levels can cause 'olfactory paralysis, severe lung and eye irritation, and pulmonary edema." Mwinyihija, "Main Pollutants and Environmental Impacts of the Tanning Industry," 22.

[202]Used by dyers and almost certainly also by tanners. Dembinska, *Food and Drink in Medieval Poland*, 53.

mans' waste was their useful tool with dog dung and urine acting as key ingredients. After these many noisome stages, the skins were taken and soaked in water infused with crushed oak bark for up to two years to properly "tan" them.[203] In a move that shows interest in promoting the tanning trade despite its unsavory aspects, the king granted a privilege to the tanners to build a mill known as *Debowa*, (Oak mill) along the Rudawa in Garbary to help grind the tree bark which produced the tannin used for processing hides.[204] White tanners followed the same steps as their fellow leather workers up until the point of leaving the skins in the tanning-bark liquor to soak. Rather than soaking the skins at this point, the white tanners would take the hides and rub them with a paste of egg yolk, salt, and alum. This method produced a very soft white leather, but one which was not impermeable to water and thus not truly "tanned". Furriers used this same final step as the means to preserve their skins. [205]

The most odoriferous parts of the tanning and tawning process was initial skinning stage, often involving putrefaction and then the de-liming, where guano and urine were used. The whole process however, impacted the water, downstream of Garbary as tanners dumped rancid wash water, flesh and hair scraps, lime solution, tanning effluent, and dung into the Rudawa. Salt too from the initial rinsing of preserved hides might potentially disrupt aquatic-life and cause soil salinization. The city sought to manage these issues by delimiting the space in which tanning could be performed but the wastes produced were still noxious to anyone located

[203]While tannins occur naturally in a wide range of plants including: hemlock, chestnut, ash, willow, and pine, oak was the most commonly used, and was in fact legally mandated for making cow leather in some places. Roy Thomson, "Leather working processes," in *Leather and Fur*, ed. Esther Cameron (London: Archetype Publications for the Archaeological Leather Group, 1998), 7. Oak was likely the most popular choice of tanning material because of the tree's tendency to produce "gall nuts" or "oak apples", these 2-5 cm nut like formations occur when a particular species of wasp plants its eggs on the tree, chemicals released by the larvae as it develops causes the tree to form a gall. These galls contain large amounts of tannin. Such galls also used in the production of iron gall ink. Given that the mill granted to the tanners was named *Debowa* (Oak mill), the tanners of Krakow must have followed this general practice as well. For more on galls See: Fagan, "The Uses of Insect Galls," *The American Naturalist* 52, no. 614 (1918): 155–76.

[204] Bieniarzówna, *Dzieje Krakowa*, vol. 1, 344–45. For information on Tanning Mills see: Lucas, *Wind, Water, Work*, 248–51.

[205]Another method sometimes used was called Leipzig Dressing, whereby the pelt was immersed in a fermented barley mash, which introduced enough organic acids to the skin that it prevented bacterial action, but did not damage the fur Thomson, *Leather and Fur*, 8.

nearby. Fur manufacture on the other hand was never as polluting or unpopular as the other tanning trades.

Furriers

The furriers, compared to the tanners appear to have held a higher status within the Krakow burgher community.[206] Theirs was the first guild to receive an official statue and they were placed in charge of guarding the critical Florinska Gate, which given its location also means it seems unlikely that they carried out their work in Garbary. That the furriers were considered differently than the tanners can be explained by the fact that their job involved fewer sordid stages and thus acquired less stigma. Indeed, their activities might have actually contributed to water purification rather than increasing pollution. In order to cure the hide but not damage the luscious fur, skins would be soaked in an alum infused bath for several days and the liquid then discarded. Alum, which is a naturally occurring mineral that was highly prized for its scarcity during the medieval period; functioned as a preserving agent for the hides but it is also a natural flocculent that in modern times is used to treat water pollution all over the world.[207] Furriers' waste water would thus potentially improve water quality rather than denigrate it. Furring, because it did not involve the noxious processes required for tanning and may even

[206]Skins were an incredibly valuable commodity and in places where hard specie was scarce skins were bartered as "fur-money" with marten pelts set as the standard unit of measure. This direct translation of skins to currency no doubt raised the standing of the furriers guild as the pelts poured into Krakow from the countryside and the forests of Hungary, Lithuania, and Russia. The exotic furs brought to the city from these places included otter, fox, beaver, wolf, marten, and even lynx and for the more humble folk sheepskin coats were a common feature of the Krakow marketplace. It is estimated that about 50,000 pelts were exported annually to the West from Poland, mainly via and Krakow and Poznan. Jacques Le Goff, *Money and the Middle Ages: an essay in historical anthropology*. (Cambridge: Polity. 2012), 60. Carter, *Trade and Urban Development in Poland*, 127.

[207] Alum, or more correctly, potash-alum [$KAl(SO_4)_2$], is a naturally occurring sulfate mineral. Flocculants encourage dirt particles in water to "floc" together allowing them to settle naturally and making it easier for people to filter them out mechanically. For more on alum's modern water treatment application see: "Water Sanitation Health," World Health Organization, accessed April 23, 2016, http://www.who.int/water_sanitation_health/dwq/wsh0207/en/index6.html "Alum | Chemical Compound | Britannica.com."

have helped the local water systems meant that fewer restrictions were placed upon them by the city.

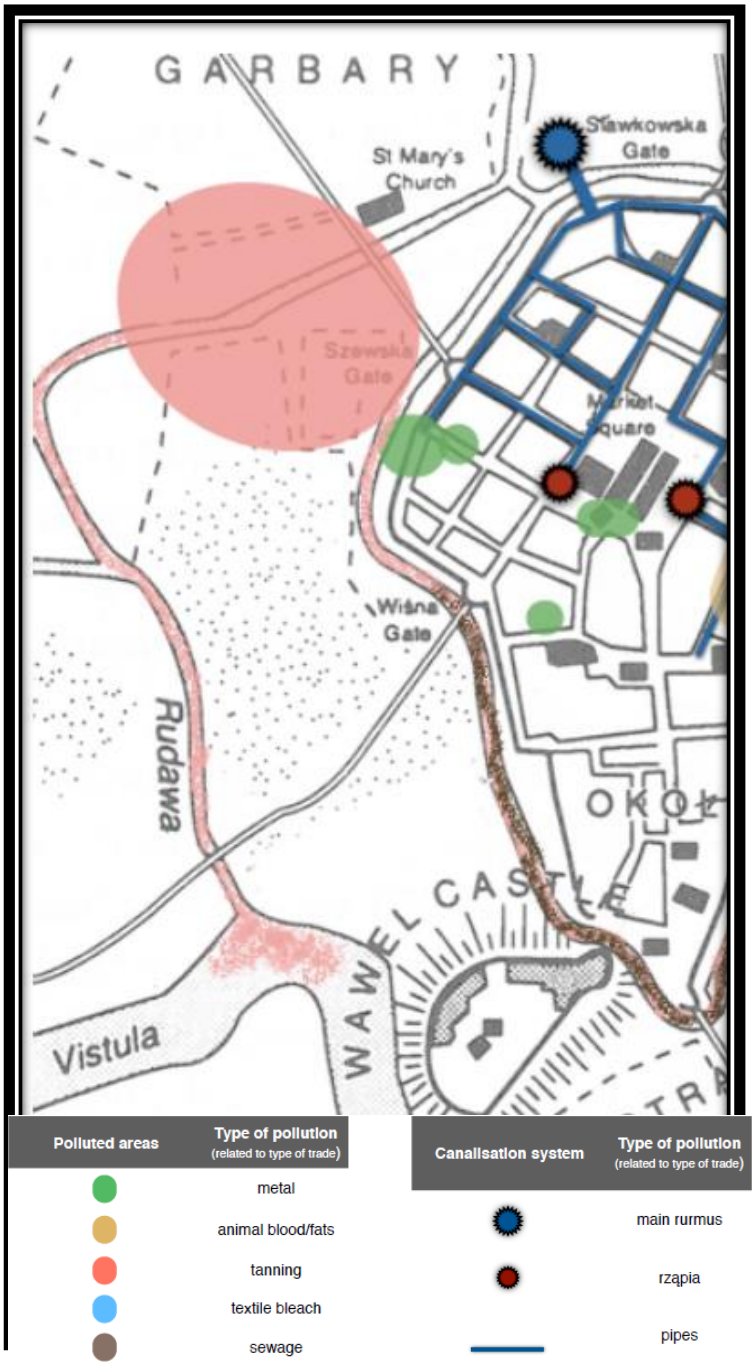

Figure 34: Map showing the area of Krakow subject to tanning pollution
(Map from: Carter, Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 1795, 66) Markings by the Author and Karol Nowoszynski

Unlike with the metallurgic guilds, the municipal government did take some action to prevent tanning waste from infiltrating the domestic urban environment. The tanners were confined to

do their work in the Garbary district, downwind from the city. As invested as they were in the skin and fur trade, municipal leaders were unwilling to try to prevent such a lucrative industry from carrying out its craft. Thus, the municipal government sought to manage the pollution produced by these industries by cordoning them off into segregated area beyond the of the city walls. This "zoning" technique was a common one employed by city officials to try to limit the impact of polluting trades upon the urban environment by confining it to a single area. Krakow did not take the matter as far as many other cities, where tanners permitted to dump their waste only at night or in very specific sections of the river were the current was swiftest.[208] The "banishing" of the tanners beyond the city walls however, should not be viewed as the city government rejecting the craft completely. The Garbary site was in fact, an excellent location with the nearness of the Rudawa River (Fig. 34) making it an ideal location for tanneries to operate allowing them to soak and rinse their skins and to power their bark-grinding mill. In this way, while the waters downstream of Garbary were abandoned to their polluted fate as long as the city's fresh water was taken from upstream, the set up working to the advantage of all.

[208] In Bologna for example the relevant statute ran: "tanners' waste (multitium)…is not to be disposed of in the city or suburbs except into the Aposa or Savena, when it flows, and then only at night." "statute di Bologna dell'anno 1288" Trevor Dean, *The Towns of Italy in the Later Middle Ages* (Manchester: Manchester University Press, 2000), 61. For further examples see: Zupko and Laures, *Straws in the Wind*, 84-85. Jørgensen, "Local Government Responses to Urban River Pollution in Late Medieval England," 39-40.

The Meat Processing Trades

Butchering

Meat was big business in Krakow during the fourteenth and fifteenth centuries. By that time, now and again bits of savory flesh could be afforded even by the peasantry while it was common fare on the tables of the well to do and most especially at the Royal Court.[209] As was the case in many cities, the *Rzeznicza* (Butchers Guild) was a particularly powerful institution, organized even before the city's incorporation it remained significant thereafter.[210] Indeed, an entire Quarter of the city came to be known as, *Rzeżniczy* (The Butcher's Quarter).[211] This district, comprising the North-eastern section of the city was unsurprisingly the area where the butchers practiced their trade, centered around the *Ulica Siena* (Siena Street), then known as the *Platea Carnaficium* and the *Mały Rynek* (The Small Market) then called the *Marcellum Carnium* located just off of the main market square behind the church of Santa Barbara.[212] The medieval names of the roads in this area, *Ulica Świnia,*(Pig Street) and *Ulica Krowia* (Cow Street), give witness to the many animals there who went under the knife (Fig. 35).[213] Animals not only made their way to the table, but were also used to make many other items: bone knife handles, horn combs, candles, leather, brushes, etc. Yet, with this great abundance came a great deal of potential pollution problems. Animals left mountains of manure (discussed in chapter 1) and the slaughter and sale of flesh and bone created wastes that quickly spoiled.

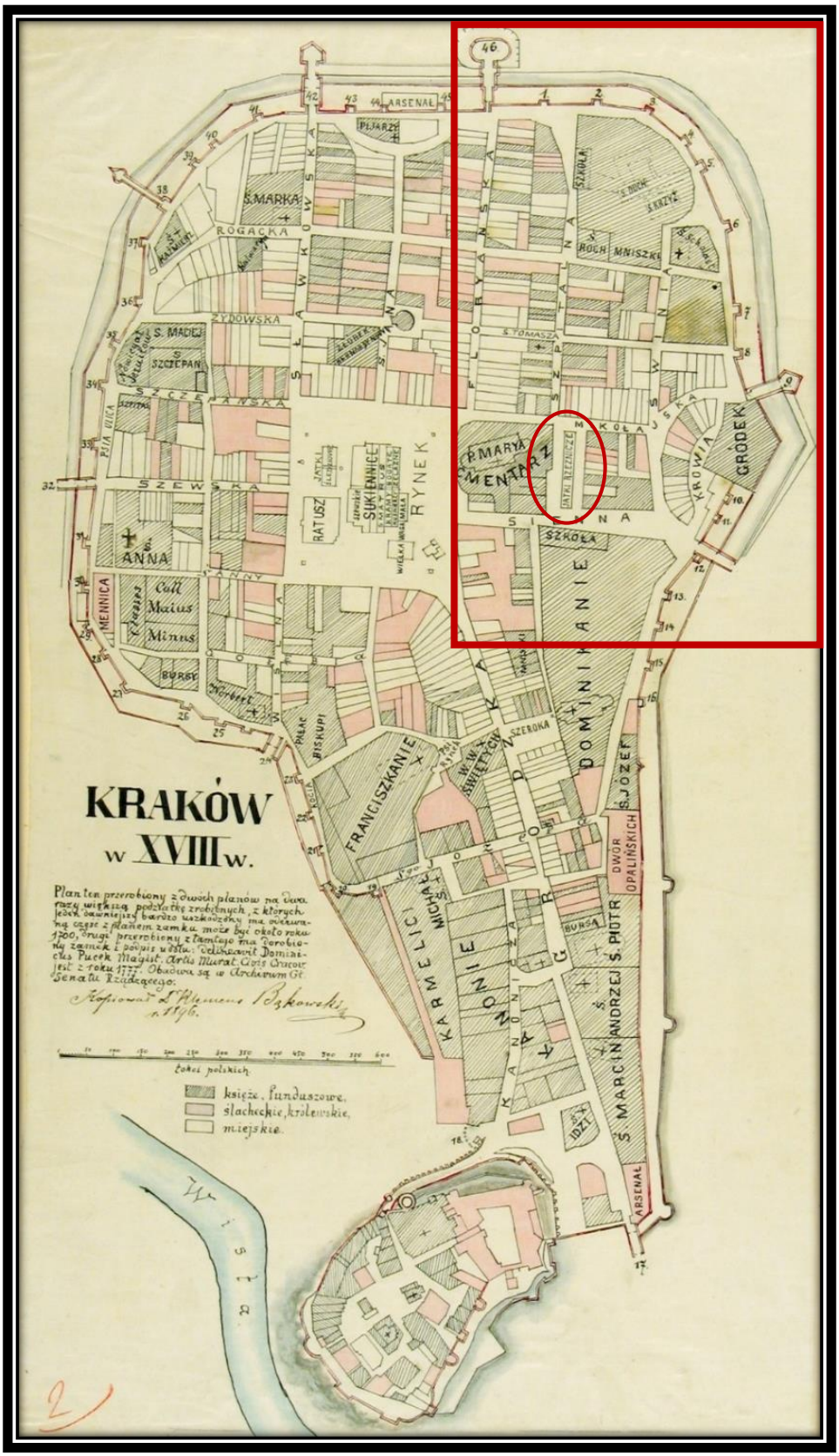

Figure 35: Map showing the Butcher's Quarter and the Mała Rynek of Krakow
(Krakow as it was in the eighteenth century retains the original street names and layout of the city from the earlier period.
Plan Klemensa Bąkowskiego - XVIII wiek)
http://www.starykrakow.com.pl/dawne-mapy,plany/mapy.htm)

City Management of the Butchers

Figure 36: German Butcher dispatching a goat. 1450
(Ott Plosse [Amb. 317.2° Folio 71 verso (Mendel I)] Nuremberg Public Library http://medievalcookery.com/paintings.html?germany)

The surviving city records show no directly waste-related regulations directed at the butchers by the Krakow city council. This is very unusual, as butchery tended to be one of the most highly regulated trades. [214] Odd as well, is the fact that despite the butcher's guild's obvious status in Krakow it does not appear in the Behem Codex and there is no record that they ever

[214] Butchers were highly regulated in other places. For example: in the largest cities like London or Paris where, upwards of 250,000 animals were slaughtered for market annually, butchers city officials sought to impose zoning laws to help deal with the problem. Paris ordered its butchers relocate to a stream beyond the city limits in 1366 while London officials tried to move the shambles to Winchester between 1369 and 1381 with limited success. In smaller cities like Verona and Bologna, animals might be butchered inside the town but blood and offal were not to be stored inside the city and any refuse had to be carried away by night while in Ghent and Noyon it was taken to special pits located outside the city walls. The regulations in Siena were particularly strict, zoning butchers to areas away from prestigious sites, ordering them to carry any waste beyond the city walls only after dark, and employing the hated Gabella Bestiarum which taxed any cattle on the hoof to be butchered for sale within a two mile radius of the city. , *333*. Daniel Philip Waley, *Siena and the Sienese in the Thirteenth Century,*10-11.

received an official statute. This lack of a statute makes it impossible to say if the guild regulations included self-censoring waste practices making civic intervention unnecessary; but it remains a possible explanation for the otherwise mysterious lack of intervention by the civic authorities who in most cities implemented strict regulations not only to combat waste but out of a legitimate concern for public health.

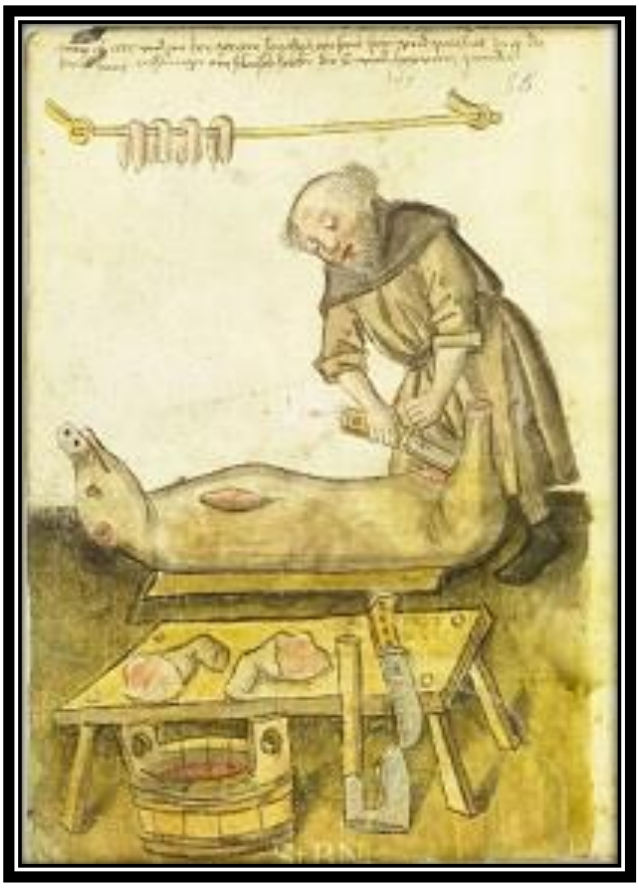

Figure 37: German butcher with blood and sausages 1465
(Hans Enßlinger [Amb. 317.2° Folio 83v (Mendel I)] Nuremberg Municipal Library http://medievalcookery.com/paintings.html?germany)

As there was no means of refrigeration, the danger of people attempting to sell rotten meats which can spoil within hours, was a real concern.[215] Because of this concern for freshness, butchers in German towns in particular were made to do their dirty work directly at a central

[215]Modern advice suggests meat be not be consumed if left out at room temperature for more than 2 hours. United States Department of Agriculture Food Safety and Inspection Service, "Ground Beef and Food safety,", accessed 19 April, 2016,http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/meat-preparation/ground-beef-and-food-safety/CT_Index; Zupko and R Laures, *Straws in the Wind*, 78–80.

meat market where prospective buyers could watch their pig turn to pork before their eyes (Fig. 34/35). While no records I could find demanded that butchers follow this practice, it appears to have been the case in Krakow as well. Animals were grazed in pastures rented out by the city located beyond the New Gate to the west behind the church of St. Nicholas. This site was conveniently right next to the shambles set up near the city walls just below the bastion cared for by the butchers' guild (Fig. 38). [216]

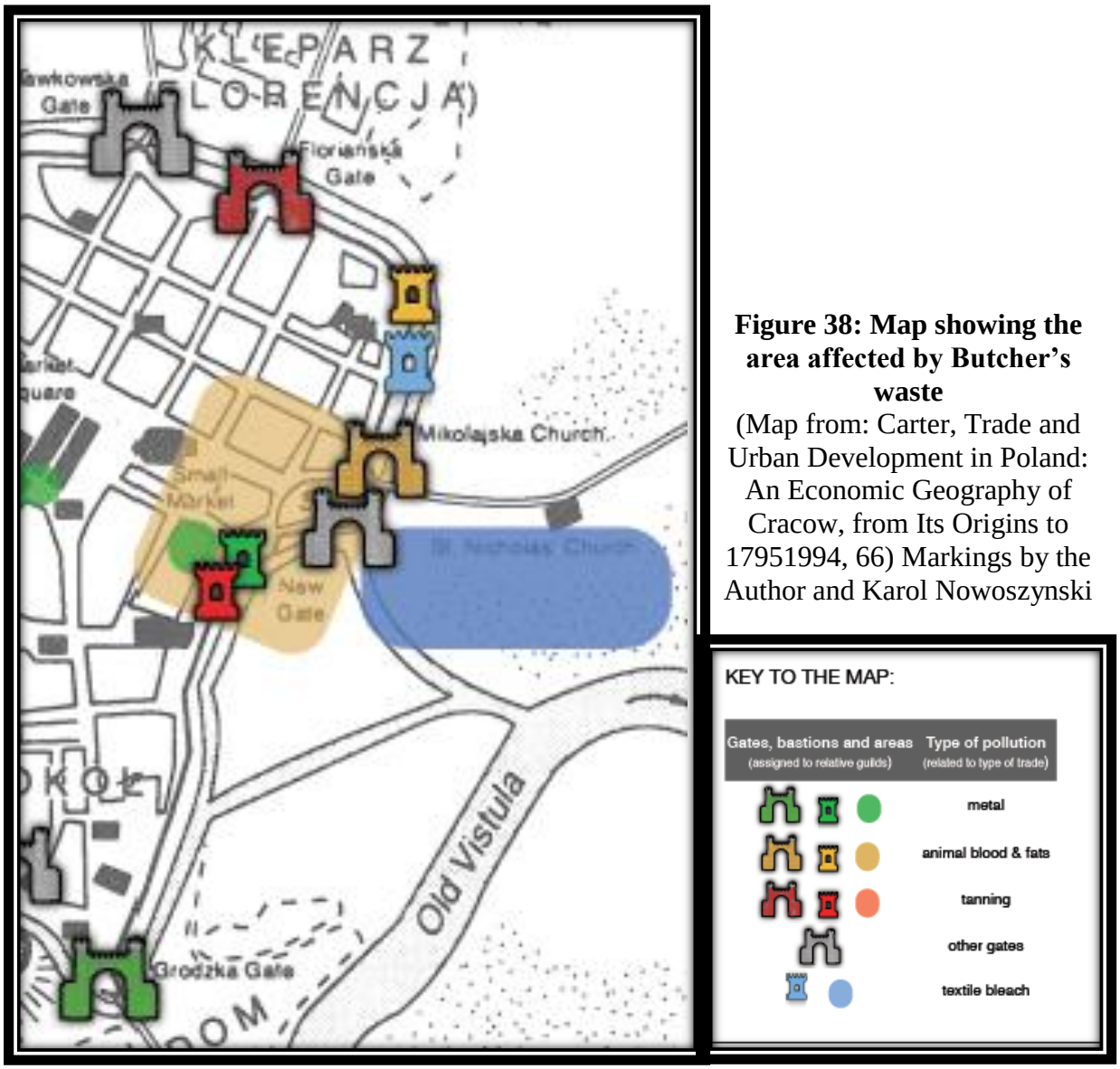

Figure 38: Map showing the area affected by Butcher's waste
(Map from: Carter, Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 17951994, 66) Markings by the Author and Karol Nowoszynski

[216] The gate was also known as the *brama Rzeznicza* or *Valva carnificum* (the butcher's gate). "Dawne warownie krakowskie" [The defenses of Krakow], *Rocznik Krakowski* 13 (1911), accessed February 12, 2016, http://www.zwoje-scrolls.com/zwoje41/text15p.htm.

At the shambles, the animals were killed by having their throats slit which was quick and somewhat clean as it allowed much of the blood to drain towards the moat. The carcasses were then hauled the short distance up to the *Mały Rynek* where the animal was further dressed where everyone could see.[217] Haunches and steaks were of course popular but intestines too were used for sausage casings and blood for soups or stuffing. In Krakow particularly, both blood and intestines were likely kept more often than in other places as *czernia* (blood soup) and *farcimina* (blood sausage) were popular, a fact that fortuitously lessoned the amount of waste flushed out of the square.[218] Such offal as tripe would also have been eaten, but only by those who could afford no better.[219] Many years later, in the seventeenth century, another use was found for these unwanted messy meats when the king ordered that slaughterhouse offal be delivered to the city zoo.[220] After this initial stage, animals were dressed and cut into joints within the square, with the meat being sold at the butchers' stalls while the horn, skin, bones, feathers, and fat might be sold on to other crafts for uses in the first step of a cycle which saw the animal used from tip to tail. The resulting liquid mess might then be tossed down the public gutter as the *Mayła Rynek* was located not far from the outlet of one the two major outflows for the public gutter system which ran just off of the *Platea Carnificum* and out through the New Gate.[221] In later years, such actions would raise outrage as residents complained of great piling up of filth outside the butcher shops and shambles which blocked canals and sending off clouds of malignant vapors.[222] In

[217] The city special ponds for water livestock were built in these municipal grazing pastures. Niemiec, "Bruki na placach," 284-85.
[218] *Kiszka* in modern Polish. Dembinska, *Food and Drink in Medieval Poland,* 90-91.
[219] Ibid.
[220] Zajęcki, "Przepisy dotyczące chowu," 115.
[221] Further research is needed to definitively answer this vexing question of the butchers waste but complaints from the seventeenth century show that this was very likely the case whether it was legal or no. Normally, the civic authorities looked askance at people tossing muck into the public gutters so the butchers may very well have been forced to carry their wastes away to be tossed into the moat or conveniently buried. Sowina, "Kanały wód odpływowych,", 269, 271. "Kamienice" [Townhouses], *Stary Kraków.* Accessed 2/May//2016 *http://www.starykrakow.com.pl/dawne-kamienice/kamienice_krakowskie.htm*
[222] These complaints come from the *Księga wiertelnicza krakowska = Quartaliensium recognitiones et divisions,* a set of audits of city infrastructure kept beginning in 1568, taken from: "Kamienice" [Townhouses], *Stary*

the earlier period however, I could find no record that the Krakow city council did anything to prevent the practice.

As stated, this hands off approach taken by the Krakow city council was very unusual as other cities zoning where butchers could work, where they had to dispose of their wastes, and at times also heavily taxed the industry as an indirect means of controlling it.[223] It is possible that records have been lost but I have so far found no indication that the city intervened in any of these ways during the medieval period beyond having the butchers do their work at the *Mały Rynek* which was owned and rented by the city.[224] In fact, butchers were actually granted special privileges and tax breaks and all products brought to the city by local peasants who provided the bulk of the city's daily fare were duty free.[225] It appears if truth be told that, refuse creation was in fact constrained more by the religious authorities than the civil ones. The Polish kingdom as a rule kept strict religious fasts which meant no meat was sold or consumed on Wednesdays or Fridays, for the entire period of Lent, or on the Ember days.[226] I have no good explanation for why the city council did not seek to implement greater control over the butchers when later accounts show that the system did give rise to complaints. They might easily have adopted some of the measures employed by other cities, zoning, product controls, and taxes that would have benefitted the civic authorities by providing cash and helped ensure public health. Perhaps, the Krakow city

Kraków. Stary Kraków. Accessed 2/May//2016 http://www.starykrakow.com.pl/dawne-kamienice/kamienice_krakowskie.htm For more see: Krystyna Jelonek-Litewka, Aleksander Litewka, and Łukasz Walczy, *Księga wiertelnicza krakowska / Quartaliensium recognitiones et divisiones*, vol. 1-6 (Krakow: TMHiZ, 1997).

[223] Siena stands as an example of the opposite extreme where at one point the city council employed three men for six months whose purpose was, "making ordinances against the butchers." William M. Bowsky, *A Medieval Italian Commune: Siena under the Nine, 1287-1355* (Berkeley: University of California Press, 1981), 142-45; Waley, *Siena and the Sienese in the Thirteenth Century*, 58.

[224] In a privilege granted by King Casimir the Great in 1358, previous privileges and ownership of various sites of the city were confirmed including the, "Maccellum Carnium cum suo censu." Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506*, vol 2, nr. 32 pg. 36-8.

[225] Carter, *Trade and Urban Development in Poland*, 31-2.

[226] Fish instead might be eaten on these days which of course produced their own wastes, but less than meat. Ibid.

council failed to implement them due to the political sway of the butchers within the city, but the issue remains a mystery.

Saolelnikow (Lard Makers)

One step removed from the butchers were the *Saolelnikow* (Lard Makers). These craftsmen would purchase bits of trimmed fat from the butchers, boil it down in large kettles and then strain the result to produce cooking *shmaltz* from poultry, *smalec* from pork and tallow from beef and mutton suet which was used to make candles and soap.[227] Large quantities of lard was needed as vegetable oils were rare so far North.[228] Krakow *Saolelnikow* were known to be particularly skilled, producing a very special type of leaf-lard called *loszijna,* for the king's pastry chef. They were also influential in helping develop Krakow's soap making industry.[229] As useful as it was, this process of making lard was messy and could smell horribly. The problem was especially acute in summer when the fat had to be rendered quickly and was not always done in time. This eventually constituted a great enough pollution problem that in a highly unusual move, the city council stepped in and banished the tradesmen to work outside the city walls. [230]

City Management of the *Saolelnikow*

The civic authorities took a direct interest in the guild's operations as from 1378, the city itself owned a smelting facility in Kasimierz which they rented to the guild. Later on, the lard makers were granted the special privilege to build a mill to aid them in their work. [231] In 1464,

[227] Shmaltz was obviously preferred within Krakow's Jewish community while smalec remains popular in Poland to this day. Janina Bieniarzówna and Jan M. Małecki, *Dzieje Krakowa,* Vol. 1 (Krakow: Wydaw. Literackie, 1992), 361.
[228] Dembinska, *Food and Drink in Medieval Poland,* 71.
[229] Dembinska, *Food and Drink in Medieval Poland,* 88.
[230] Ibid.; Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506,* vol 2, no. 334, 6.
[231] Bieniarzówna and Małecki, *Dzieje Krakowa,* vol. 1 (Krakow: Wydaw. Literackie, 1992), 369.

however, a statute, summarizing and reaffirming previous city laws introduced a new regulation prohibiting the smelting of grease within the city walls but permitted it to continue outside at designated sites.[232] Here again, zoning was the civic authorities' weapon of choice to limit pollution in the city by sequestering a problematic trade. Out of sight, out of smell, out of mind it seems. However, in Krakow, this statute marks one of the very few times that the city stepped in, no doubt due to the unpleasant and therefore dangerous smells rendering produced, but also perhaps in equal measure to the accompanying fire hazard. [233]

Fishmongers

Fishmongers were also present in Krakow and sold their wares primarily at the "fish market." This group appears to have been a very minor entity in Krakow.[234] The guild does not appear in the Behem codex and shows no sign of having acquired an official guild charter. The fresh fish sold in Krakow, came from the rivers surrounding the city or local fish pounds owned and operated by monastic orders or rented out to residents by the king. [235] Barrels of salted herring came down from the Baltic coast, as did eels which appear to have been a particular delicacy.[236] Fish would have been eaten most commonly on fasting days, where it took the place of meat. Yet, while scaling and cleaning of fish could be a messy business, it was much less so than butchery or other meat-related trades and records show no restrictions being placed on the trade.

[232] Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506*, vol. 2, no. 334, 6.
[233] Bieniarzówna, *Dzieje Krakowa*, vol. 1, 369.
[234] Nicholas, *The Later Medieval City*, 218–20.
[235] Sowina, "Water Supply of the Late Medieval and Early Modern Town in the Polish Lands," 11–18.
[236] Carter, *Trade and Urban Development in Poland*, 134–39.

Textile Production

While the textile merchants were highly influential in Krakow as in so many other cities, it was not a particularly great center of cloth production. The form of textile the city did produce in large amounts was fustian, a blended fabric, most commonly warped with cotton threads with the weft worked in linen or occasionally wool. Fustian, as a lighter, cheaper, textile soon became popular after the introduction of cotton to the continent with the Norman conquest of Sicily in the eleventh century.[237] Cotton arrived in Krakow around 1420 and over the next ten years revolutionized the city's textile guild as they adapted to become a hub of fustian manufacture.[238] By 1456, the guild had grown enough that it was granted an official statute.

The most polluting part of textile production occurred only after the cloth was fully woven. Once stripped from the looms, the fabric needed to be cleaned and fulled so that the fibers would felt more closely together. For this, various cleaning agents were used including soap, urine, natron, Fuller's Earth (aluminium silicate), Gypsophila struthium, soapwort and especially potash-lye (potassium hydroxide).[239] The cloths would be then set into a large barrel and stomped on in order to full the fibers until 1458, the king granted them the privilege to, build a fulling mill on the section of the moat which ran behind the church of St. Nicholas.[240] The location of this mill might have been a problem for the cleaning of cloths considering that

[237] Angela Ling Huang and Carsten Jahnke, *Textiles and the Medieval Economy: Production, Trade, and Consumption of Textiles, 8th-16th Centuries* (Oxford: Oxbow Books, 2014).

[238] "Several varieties of cloth were manufactured in Cracow (bloser, selbfar, loden (or fleecy cloth) and szotte) and in Kazimierz, which satisfied local demand, any surplus being exported." Carter, *Trade and Urban Development in Poland*, 153. It should be noted, however, that only the fustian weavers appear to have been singled out in guild registrations. The Weavers' and Fustian-makers' Guild of Kleparsz (*tkaczy i barchanników kleparskich*) 1456, the Weavers' Guild of Kazmimierskich (*tkaczy kazimierskich*) 1457, and Weavers' and Fustian-makers' Guild of Krakow (*taczy i barchanników krkowskich*) at some point before the first two. Bieniarzówna, *Dzieje Krakowa*, vol. 1 (Krakow: Wydaw. Literackie, 1992), 335, 441-42; Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506*, vol. 2, no. 327, 328, 331.

[239] Ibid.

[240] Privilege issued December 15, 1458. Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506*, vol. 1, no. 167.

the butcher's shambles and the spill site for the main city gutter was also set just at this point along the moat. However, improvements made in 1401 split the moat at this critical junction into two channels so that fustian fulling could go on without the delicate cloth being endangered by bobbing sewage or entrails floating downstream.[241]

Bleaching

The last step in the production process was the bleaching or dyeing stage. Most fabric woven in Krakow was farmed out to other specialized cities to be dyed but the bleaching was done in-house.[242] In 1452, the city rented a section of the pasturage located behind the church of St. Nicholas beyond the city walls not far from where the fustian guild would a few years later build its mill, for the laying out of bleached cloth to dry.[243] Bleaching techniques had improved during the thirteenth century. Finished fabrics were rolled and placed in a tank filled with water for twenty four hours, after this, the cloth was removed and spread out to be sprinkled with potash, lye, or other cleansers it was then rolled up again and placed in a tub of warm water that was changed several times a day with the excess being dumped into a nearby waterway.[244] The cloths might also be scoured with brushes, pounded with rods, or trampled on with feet to beat out the dirt. Once this was done, the cloths were rinsed and spread out in a meadow to be exposed to the sun for up to two to three weeks in a cycle that might be repeated three to five times.[245] The work of the *blicharz* (bleacher) was a summer-time activity.

[241] A privilege issued in June 23, 1401 ordered the digging of new moats from the Mikołajska gate up to the Grodzka gate Piekosiński, *Kodeks dyplomatyczny miasta Krakowa 1257-1506*, vol. 1, 138, no. 98.
[242] Carter, *Trade and Urban Development in Poland: An Economic Geography of Cracow, from Its Origins to 1795*, 295.
[243] Bieniarzówna and Małecki, *Dzieje Krakowa*, vol. 1, 340.
[244] Urszula Sowina, "L'eau et les nouveautés techniques dans l'espace urbain et suburbain au Moyen Age [Water and technical innovations in urban and suburban space in the Middle Ages]," *Actes des congrès de la Société d'archéologie médiévale* 6, no. 1 (1998): 85.
[245] Ibid.

All of this work of course released a great deal of cleaning agents into the environment but most were quite easily bio-degradable.[246] The exceptions to this would be potash lye and ammonium. Potash lye (potassium hydroxide) can be very caustic and cause nasty burns and throat and eye irritation if the solution is too concentrated, but it is water soluble and once diluted by the waters of the Rudawa would not have had a significant negative impact.[247] Another common bleaching agent was what we would normally consider a useless waste product; urine.[248] Urine, if given time to sit will degrade into ammonia. Bleachers would collect urine and store it for a time causing the urea in the jug to ferment into ammonia which was then mixed with water to form a powerful cleaning solution. Pure ammonia is quite toxic however, irritating to the lungs if it is breathed in as a gas and when introduced to water systems acts as a fertilizer and can stimulate problematic algae blooms. Bleachers would have chosen to use either lye or urine-ammonia as the mixing of the two produces lethal ammonia gas. While drinking the water just down-stream of the bleaching courses would not have been advisable, after a time the water current would have dispersed the worst of the mess. Those who would have been most effected by both lye and ammonia's caustic properties would have been the bleachers themselves who likely suffered painful irritation of their hands and feet and stinging of the eyes and throat.

[246]Apart from the organic plant based cleansers, fullers earth was a common additive. Fullers Earth (aluminum silicate), is a naturally occurring rare-earth clay that acts as an excellent de-greaser and scouring agent. It is also no at all harmful to the environment and has in modern times become popular additive in cosmetics "Fuller's Earth," *Encyclopedia Britannica*, accessed April 14, 2016, http://www.britannica.com/science/fullers-earth.

[247] As an alkaline solution it could increase the ph of a local water system. "ATSDR - ToxFAQs, Sodium Hydroxide," accessed April 14, 2016, http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=248&tid=45.

[248] The question of how urine might have been bought and sold for the purpose is a fascinating one but sadly very difficult to track in the sources.

City Management of the Textile Industry

As the cloth trade and manufacture was important to the economy of medieval Krakow as it was most other medieval cities, but the manufacture of fustian was a relatively late addition to the city's crafts. As dyeing never became a big industry in Krakow, textile manufacture was not a major contributor to pollution. The weavers and bleachers practiced their trade beyond the city walls because they required space and access to running water, not because their work was exceptionally noxious. Beyond encouraging their business, the city had little need to manage the activities of this guild except to protect them from the pollution of others. The handing over of the section of the moat Rudawa for use by the fustian weavers separated from where the wastes of the butchers and the general city gutter system shielded the delicate fabrics from these wastes and allowed the guilds to flourish.

Chapter 3 - Domestic Waste

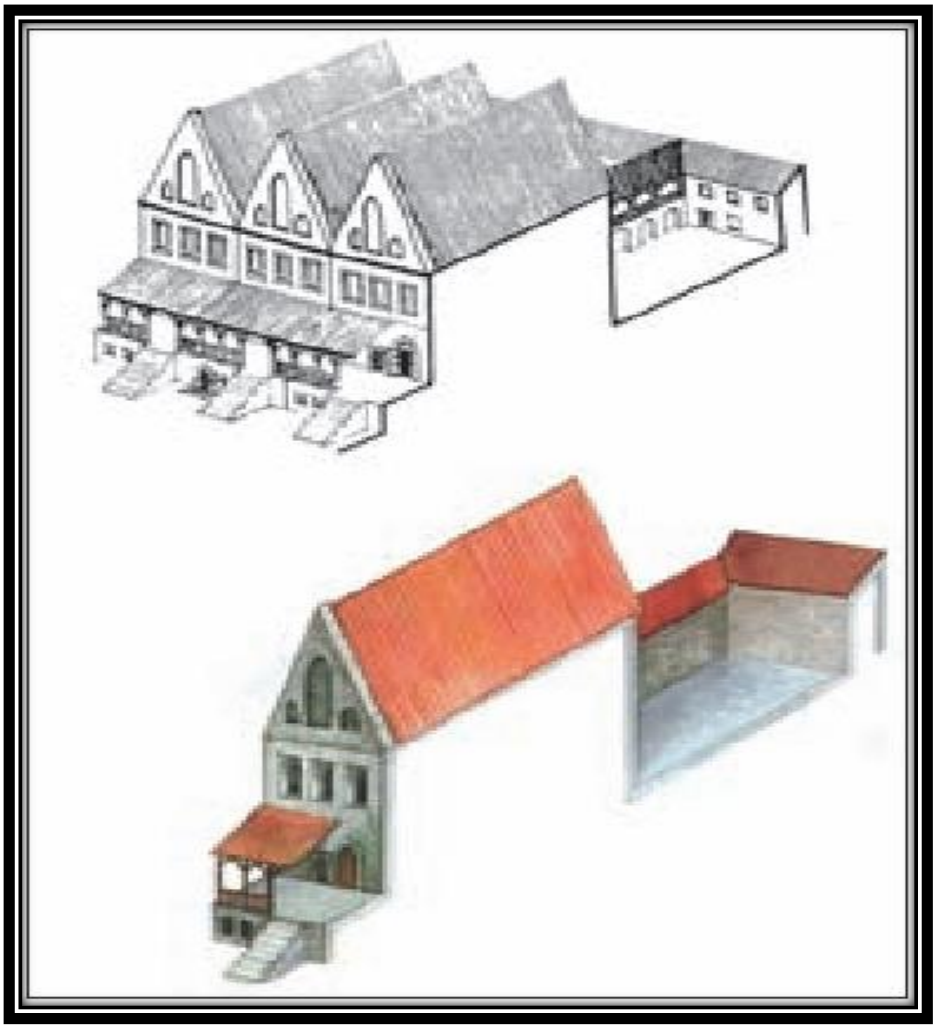

Figure 39: Krakow burgher house reconstruction,
First half of the fourteenth century
(Nimiec, "Średniowieczny rynek krakowski" [The medieval main square of Krakow], 90)

Between the fourteenth and the sixteenth centuries, Krakow transformed from a city built primarily of wood, to one of brick and stone, so that by 1493, it was described as the, "most distinguished city of the kingdom." [249] During this time, domestic space in the city underwent many changes. By the start of the fourteenth century, Krakow townhouses were large but comparatively narrow multi-story structures with their fronts set flush with the

[249] Hartmann Schedel, *The Nuremberg Chronicle*, trans. Walter Schmauch, digital edition at the Morse Library, Beloit College, accessed February 2, 2016. https://www.beloit.edu/nuremberg/inside/about/index.htm, fol. 279v.

street (Fig. 39), and they had elongated back plots stretching out behind where gardens, animals, and outbuildings were located.[250] The most expensive homes were built around the *Rynge,* and as discussed in chapter one, here a strong push was made by the city council to keep the zone clean. However, even with proscriptive legislation in place, the frequent reissuing of those statues shows that rubbish kept piling up as people failed to keep their frontages swept clear. Without a proper garbage removal system, it appears that it was just too convenient to simply dump household trash outside. Given the lack of enforcement measures, people could easily get away with breaking the rules. Still, Krakow residents did not always dump their trash in the streets and many ways they made efforts to limit waste can be traced.[251] This chapter focuses on wastes in the home, how people sought to conserve and limit its creation, the washing away of filth and how they handled the ever present conundrum of human waste.

[250] Piekalski, *Prague, Wrocław and Krakow*, 89-90. A great deal of recent research has been done on the evolution of urban and architectural morphology of medieval Krakow whose general street outline has remained surprisingly stable over the years. For information on this topic see: Dariusz Nimiec. Uniwersytet Krakowski w badaniach archeologicznych: Archeologiczne ślady Uniwersytetu Krakowskiego" [University of Cracow in archaeological research: Archaeological traces of the Cracow University] (Kraków: Katalog wystawy w Collegium Maius Uniwersytetu Jagiellońskiego, 2006), 8-40. Piekalski, *Prague, Wrocław and Krakow*, 129-38. Kamila Follprecht, "Buildings and Dwelling of Krakow in XVI-XVII Century: Descriptions Contained in the City Deeds," *Geology, Geophysics and Environment* 40, no. 2 (June 30, 2014): 181. Stanisław Sławiński, *Przyczynek do stanu badań nad zagadnieniem najstarszych kamienic krakowskich i ich lokalizacji na dziełce modularnej* [Contribution to the state of research on the problem of the oldest town houses of Krakow and their location on the modular divide] (Krzysztofory: Zeszyty Naukowe Muzeum Historycznego Miasta Krakowa).. Klemens Bakowski, *Dzieje Krakowa* [Krakow in the past] (Krakow: Spooka Wydawnicza Polaka w Krakowie, 1911).

[251] It should be noted that many of these households discussed here did not have a strong divide between "workspace" and "home space". This meant that very often activities which were covered in chapter 2 under the title "industrial" were actually carried out in some part in the home, bringing with it all its accompanying waste.

Avoiding Waste

Figure 40: Discarded pots uncovered in a fourteenth-century cesspit at ul. Gułobia 24, Krakow (Nimiec, "Przemiany przestrzenne historycznego bloku zabudowy mieszkalnej w Krakowie na przykładzie badań archeologicznych dziedzińców Collegium Novum UJ" [Spatial transformations of the historical block of residential buildings in Krakow in the case of the excovation of the courtyards of the Collegium Novum]. 202)

Medieval Krakow was not a consumptive society in the terms we consider it today. Consumer goods were relatively expensive, and items were used until they wore out, repaired whenever possible, and when not, often recycled for another purpose. [252] In the same way that a cow slaughtered by the butcher would have its skin sold to the tanners, its hair to the brush-makers, its horns to the comb makers, its fat to the lard renderers, and so on, until from snout to rump the entire beast was used; so too did people seek to maximize their resources and

[252] Rags, for example, were purchased by people from the royal court. Dembinska, *Food and Drink in Medieval Poland*, 53.

conserve products so that as little as possible was wasted. Krakow guild regulations even encouraged consumers to push for repairs rather than buying new, by including statutes to insure that mends were done well, requiring for example that, "If the old vessel should be repaired or patched, you should do a good tin." [253] Even products that would be normally categorized as pure waste such an animal manure or urine might be made useful as fertilizer or ammonia cleaning solution. What did end up being thrown away were objects that could not be repaired and could not be burned for fuel - broken pots for example (Fig. 40)—as well as food scraps, building debris, and excess human and animal dung. These items were either pitched into the street at the front of the house or deposited in a midden pile or cesspit at the back.[254] Any item sent to the midden, however, in some way represented a failure of household management as the potential resource was lost and so householders strove hard to prevent this from happening.

[253]1515 statute of the *konwisarz* (pewter-castors) and the *ludzisarz* (bellfounders). Kazimierz Sękowski, "Statuty krakowskiego cechu konwisarzy i ludwisarzy z roku 1412 i 1512 jako źródło do historii techniki" [Statutes of Cracow guild konwisarzy and bell-founders from 1412 and 1512 as a source for the history of technology], *Kwartalnik Historii Nauki i Techniki* 29, no. 2 (1984): 423.

[254] For cesspit and midden description in Krakow see: Piekalski, *Prague, Wrocław and Krakow*, 90; Sokolowski et al., "Changes of Natural Environment in Kraków Downtown," 17.

Avoiding Food Waste

Figure 41: Dining Scene
Herod and Salome Tryptich Matki Boskij ~1500
National Museum of Krakow
(Baczkowski, *Wielka historia Polski vol. 3. Dzieje Polski Późnośredniowiecznej (1370-1506)* [The Great history of Poland Vol. 3 The Late Medieval Period (1370-

As food was a precious and seasonal product, preventing it from going to waste was a big concern for householders. The people of Krakow were better supplied with imported goods than their country counterparts, but they were still bound to the agricultural cycle. Indeed, most of the products eaten, were in fact raised in gardens within or just beyond the city walls. To encourage these plants, a problem was turned into a boon as animal manure and human

feces were used as fertilizer.[255] Meats purchased at the market, or fruit and veggies plucked from the back garden, would have to be cooked or preserved as quickly as possible, because without refrigeration, spoilage could occur in a matter of hours. Meat and fish might be salted, smoked, or preserved in aspic.[256] Vegetables might be stored in cool root cellars and were often pickled, sauerkraut and pickled beets being favored even at the royal court.[257] Fruits were eaten in season or preserved as fruit butter or jam.[258] The most common meal however, was a potage made of millet *kasha* which could be stored for longer periods. Other grains like rye and wheat were common in bread and beer purchased from Krakow's bakers and brewers, cutting down on the amount of grain and flour that needed to be stored in the home.[259] This, and the fact that milling was done increasingly beyond the city walls helped limit spillage and decrease rodent problems.[260] In these ways food was conserved so that it did not end up as waste. Some things could not be conserved however, and food scraps and spoiled bits were a fact of life. Once used, these were scrubbed clean with the use of scouring rushes (Fig.42).[261]

[255]For a full accounting of the paleobotanical finds in Krakow discovered amidst animal and human waste- laden humus see: Aldona Mueller-Bieniek, Adam Walanus, and Emil Zaitz, "Cultivated Plants in Medieval Kraków (Poland), with Special Reference to Amaranth (Amaranthus Lividus L. Cf. Var Lividus) and Ruderal Communities," *Acta Palaeobotanica* 55, no. 1 (2015): 98–115, doi:10.1515/acpa-2015-0003.
[256] Dembinska, *Food and Drink in Medieval Poland*, 91, 102.
[257]Strangely, cucumber pickles do not appear until the Late Middle Ages, an oddity for which Dembinska offers a convincing explanation. Dembinska, *Food and Drink in Medieval Poland*, 124-32.
[258] Dembinska, *Food and Drink in Medieval Poland*, 104..
[259] Mueller-Bieniek , "Cultivated Plants in Medieval Krakow," 99, 104. Dembinska, *Food and Drink in Medieval Poland*, 103-5.
[260] Ibid. Dembinska, *Food and Drink in Medieval Poland*, 103-6.
[261] Scouring rushes are a type of common marsh reed (*Equisetum hyemale*) whose woody stems can be folded and rubbed horizontally back and forth across a dirty surface to scrape off gunk. For a full accounting of Polish medieval kitchenware see: Dembinska, *Food and Drink in Medieval Poland*, 55, 63-79.

Figure 42: Scrubbing rushes *Equisetum Hyemale*
(Wikimedia Commons
https://commons.wikimedia.org/wiki/Category:Equisetum_hyemale#/media/File:Equisetum_hyemale_Tatton_1.j

Any cooking scraps, or a dish that had spoiled, were taken out to the back lot and dumped either down the latrine shaft into the underlying cess pit, or tossed onto a midden pile which was also a common feature of the back garden. [262]

[262] Piekalski, *Prague, Wrocław and Krakow*, 90.

Washing Up

Figure 43: Detail of a woman preparing water for washing
Marian Altarpiece in St. Mary's Cathedral Krakow
Wita Stwosza – 1477-89

Washing was an important way to purge the domestic environment of wastes that carried both a strong practical and complex social function. As a fourteenth-century Polish poem on table manners explains, "The meal begins with water/Before they sit down to eat;/They put it on their hands,/That's how the most worthy people meet each other/When they sit themselves at the table."[263] Lack of cleanliness meant social bungling. The poem goes on to warn that should a man eat with greasy hands before a lady, she will speak with him insincerely. This disgust at unwashed fingers makes sense as people in medieval Krakow ate with their hands,

[263] The first copy of the poem is from 1415, it is thought to have been written by Przeclaw Słota Gosławice, a nobleman from Łęczyca. "Słota, Poem on Table Manners," trans. Michael Mikós, *Staro Polska*, accessed April 20, 2016, http://www.staropolska.pl/ang/middleages/sec_poetry/Slota.php3.

often sharing from communal platters with everyone's fingers dipping in.[264] As expectations of cleanliness and behavior at table evolved, finger bowls, ewers (Figs. 44 & 45) and napkins for wiping one's hands became increasingly important through the period.[265] Yet, this cleansing of the fingers attacked only visible stains. No soap was used, and lacking an understanding of germ theory, hand rinsing was not intended to ensure "health" in our modern medical sense but rather, as Mary Douglas differentiates, was ritually symbolic of pollution being expunged. [266] This washing of filth in physical and spiritual form was an important social step before any meal. Thus, while medieval Poles did not wash their hands after using the latrine, they did do so before dining.

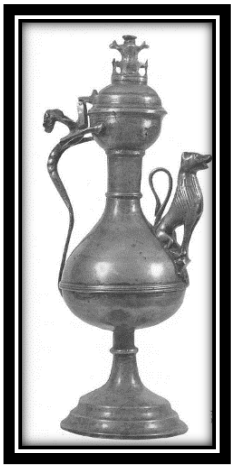

Figure 44: Ewer - Krakow 15th-16th Century
(Jelicz, Das alte Krakau: Alltagsleben vom 13. bis zum 15, 79)

Figure 45: Ewer
(Detail from the Balthasar Behem Codex Guild of the *Odlewni* (Founders) Dzwoniarze (Bell makers) Folio 281)

[264]People usually ate with their hands with the aid of a small knife, using bread "trenchers" for plates. Knives used for eating were small personal items which nearly everyone carried with them, and for which the *nozownikow* (knife-makers) of Krakow became particularly renowned during the sixteenth century. F. W. Carter, *Trade and Urban Development in Poland*, 325.
[265]For a history of the evolution in table-manners see: Norbert Elias, *The Civilizing Process*, ed. Edmund Jephcott (Oxford: Blackwell, 1982).
[266] Mary Douglass, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (New York: Frederick A. Praeger, 1966), 33.

The importance given to the washing of hands, also helps explain the high value attached to linens in medieval households and their ubiquity in pictorial accounts. Long white towels shown hanging from elaborately carved rails appear in numerous images in the Behem codex as well as in countless examples of domestic scenes in art-work from the period.

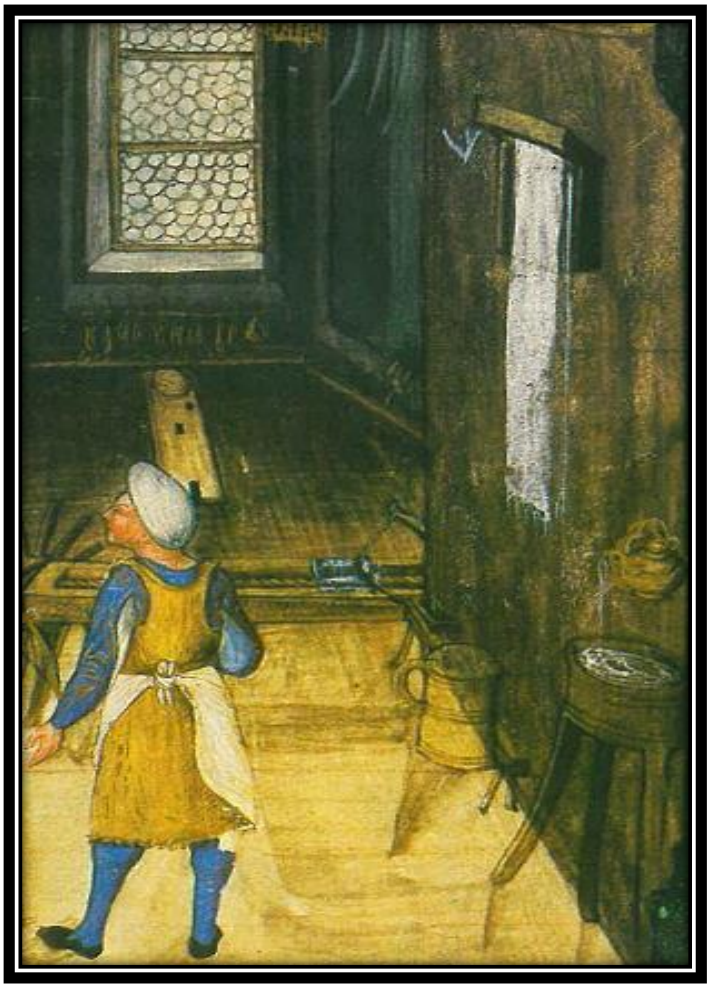

Figure 46: Detail showing a long white towel and a kettle with a washing basin (Balthasar Behem Codex Guild of the Procarnicy Grotnicy (Cross-bow and Arrow makers) Folio 260)

These towels are often depicted hanging beside a wall niche in which a kettle is suspended. (Figs 46 and 47). The kettles in turn would be filled with well-water or from taps connected to

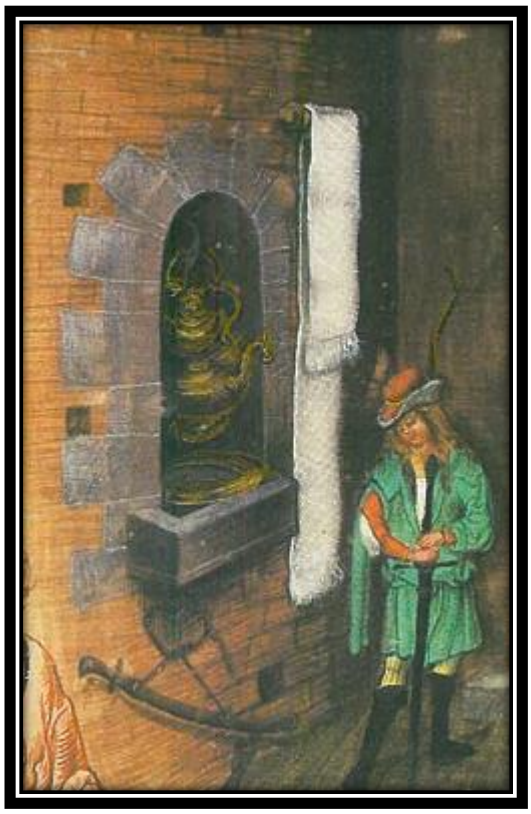

Figure 47: Detail showing a long white towel, kettle and washing basin
(Balthasar Behem Codex guild of the *Miecznicy* (knife and sword-makers) Folio 291)

Figure 48: Brass water kettle, fifteenth-sixteenth century
(Jelicz, Das alte Krakau: Alltagsleben vom 13. bis zum 15, 80)

the piping system springing from the wall.[267] As Krakow's indoor plumbing had not yet advanced so far as to run both hot and cold, the kettles once full could be easily heated and then hung back in their nook to provide warm water for washing. Washing basins set below the kettle meant that water did not drip on the floor, while in other places full sinks were set beneath the wall tap. Ewers, which were taken to the table, might also be filled from these taps. Once hands had been sprinkled with water from these ewers and towels and napkins used to wipe greasy fingers these linens then had to be washed.

[267] For those wealthy Krakow citizens lucky enough to have a direct hook up, the *rurmurs* pipe system brought water straight into the homes. The water from the wooden pipes would have been attached to a home system and sent to tanks and then to smaller pipes attached to a tap or stopcock, from which water could be drawn. This was done in order to avoid damaging the pipes when the water was abruptly shut off, causing a water hammer effect, and in order to reduce pressure which might cause the taps to burst. Roberta J. Magnusson, *Water Technology in the Middle Ages Cities, Monasteries, and Waterworks after the Roman Empire* (Baltimore: Johns Hopkins University Press, 2001), 110–13.

Laundry was a task usually carried out by women in local ponds, streams, or in large wooden tubs at home. As fustian entered the market in Krakow, it became a popular fabric for basic linens and for base-layer underclothes that people wore next to their skin. These underclothes which soaked up body oils and smell could be washed more regularly with harsher soaps and then bleached until they shone, protecting people's more expensive outer garments. [268]

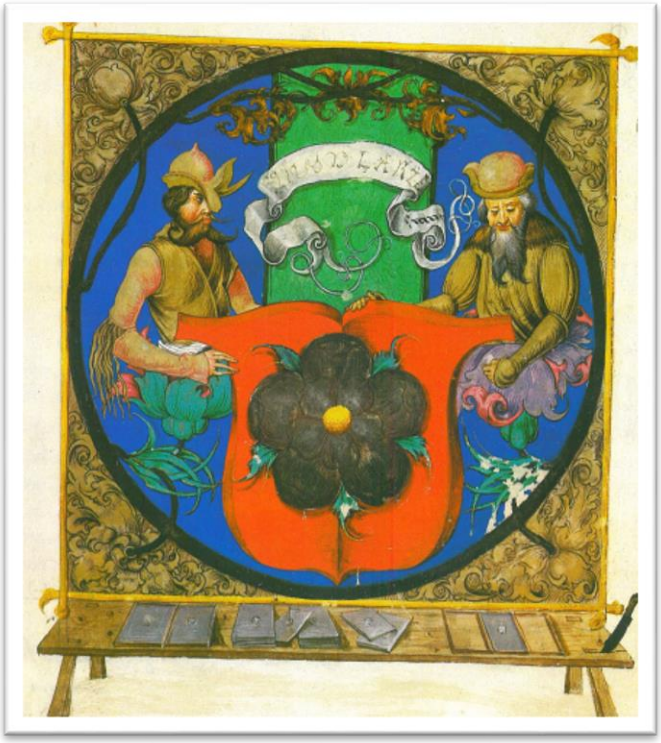

Figure 49: Image of the guild of the *mydlarze* (soap-makers)
(Balthasar Behem Codex Folio 300)

In Krakow, soap was made both at home and on a larger scale by professional craftsmen (Fig. 49).[269]

After washing, certain pieces, like ladies headdresses, those long fustian towels, and napkins, required starching. For this, ladies used *Arum Italicum* (Fig.50), a type of ornamental

[268] John Norman and Greville Pounds, *Hearth & Home: A History of Material Culture* (Bloomington, Ind.: Indiana University Press, 1993), 193.
[269] Soap was made by rendering plant or animal fat and mixing it with lye produced by slowly pouring water through wood ashes or potash. This created a strong alkaline solution with powerful degreasing properties, but which had to be carefully proportioned to avoid an overly caustic soap which would irritate people's skin. Ibid.

hibiscus imported originally from Southern Europe, but used already in Krakow by the Middle Ages.[270]

If washing was done at home, both of clothes and at times also of bodies were soaked in large

Figure 50: Arum italicum
(Wikimedia Commons
https://commons.wikimedia.org/wiki/Category:Arum_italicum#/media/File:Arum_italicum_fruits01.jpg)

wooden tubs. Adults often visited Krakow's many public bath houses, but babies were usually bathed at home. The resulting waste water could then be thrown out into the public road where it could flow into the central street gutter.[271] If not tossed out the front, the liquid might be flung outback into a series of backyard gutter channels, cut through the plots of some residences.[272] These channels would have carried waste waters and even sewage away from individual homes, flushing them out into the central system.[273] Both the street gutters

[270] Dembinska, *Food and Drink in Medieval Poland*, 55.
[271] Baths in Krakow were incredibly popular, with people going at least once a fortnight and often more frequently. Twelve public baths were eventually opened across the city with many more in people's residences. Antonina Jelicz, *Życie codzienne w średniowiecznym Krakowie: wiek XIII-XV* [Everyday life in medieval Krakow: thriteenth to fifteenth centuries] (Warsaw: Państwowy Instytut Wydawniczy, 1966), 72–8.
[272] Sowina, "Kanały wód odpływowych,"270.
[273] Sowina shows proof of this by looking at records of conflicts between neighbors when such sewage lines cut across multiple properties, and when a new party wished to build their own canal and connect to the network. Ibid.

and back-plot channels flowed away from the main market square at the center of town down towards the city walls, following the line of Krakow's topographical elevation, and eventually issuing out at two key points into the city moat. [274] The extra water added to the system only helped to move things along. By using these private back gutters, which court records show were jealously guarded by their owners, Krakow residents effectively managed to expel their waste water in a way which optimized the system as a whole.[275]

[274] The city gutter system issued into the moat on the East side of the city near the New Gate and on the west near the Wiślna Gate. Ibid.
[275] Ibid.

Human Waste

Figure 51: Likely chamber pot discovered along with other broken pottery in a cesspit in Krakow
(Nimiec, "Przemiany przestrzenne historycznego bloku zabudowy mieszkalnej w Krakowie na przykładzie badań archeologicznych dziedzińców Collegium Novum UJ" [Spatial transformations of the historical block of residential buildings in Krakow in the case of the excovation of the courtyards of the Collegium Novum], 202)

Upon waking up in the morning, the medieval residents of Krakow might have their first encounter of the day with waste when they paused to use the chamber pot (Fig.51). Such articles, often made of terracotta with a lead glaze to prevent odiferous oozing, were tucked under beds and brought out when the bladder was full but the body unwilling to make its way down and out to the rear lot latrine.[276] Once the pots were full, they were carried to the privy

[276] Johan J. Mattelaer, "Some Historical Aspects of Urinals and Urine Receptacles," *World Journal of Urology* 17, no. 3 (1999): 147.

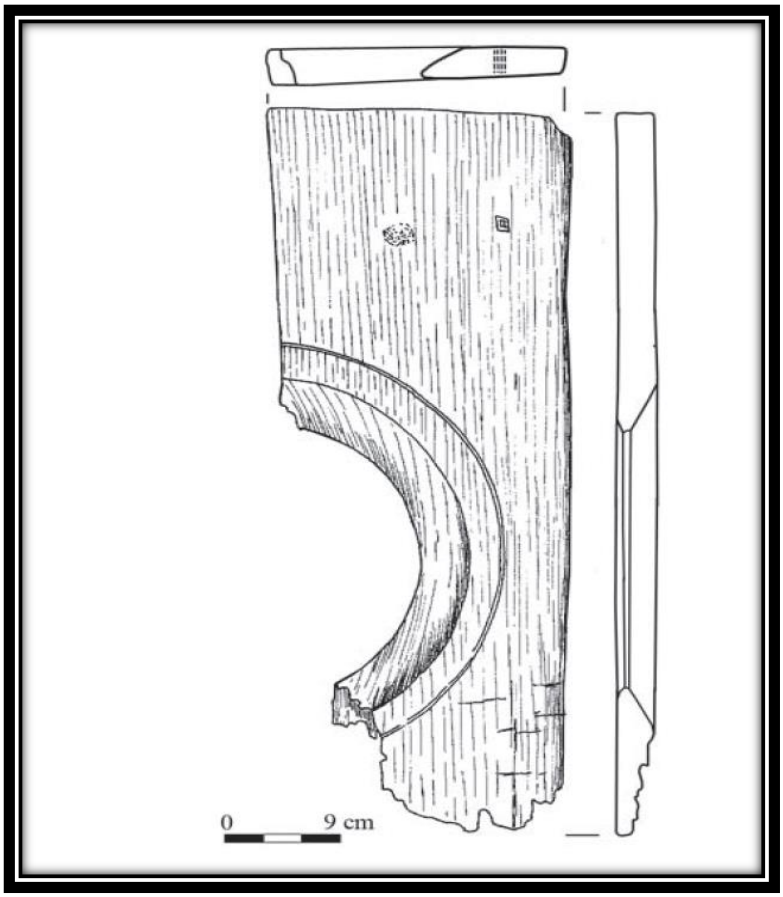

Figure 52: Medieval beveled "comfort toilet seat"
Found in a well in Kolozbregu Poland
(Cembrzyński, Zaopatrzenie w wodę i usuwanie nieczystości w miastach stref bałtyckiej i sudecko-karpackiej w XIII-XVI wieku / Water Supply and Waste Disposal in Cities of the Baltic and Sudeten-Carpathians Zones in the 13th-16th Centuries,73)

and emptied out or on occasion perhaps dumped out the nearest window as King Sigismund complained still in 1533 was often the case.[277] If the resident made it down to the privy pit however, a far more likely event perhaps in summer when smells were high than in winter when snows could be deep, what Krakow residents would have used was a classic outhouse. These sturdy little wooden huts were built with a plank seat with a hole cut out in the center and set over an underlying cesspit.[278] The wooden seat suspended over the pit was smoothed around the rim of the hole and beveled to form a "comfort fit" (Fig. 52). Many of these seats,

[277]"quarum magna pars prima et ultima quaque noctis vigilia ex fenestris funditur" The king's lament appears in a letter complaining more generally about Krakow's sordid conditions to two members of the city council at the end of which he requests that they work to rectify the situation. .*Acta Tomiciana*, vol. 15, 414-5, no. 301.
[278]; Piekalski, *Prague, Wrocław and Krakow*, 89.

particularly those in monastic houses, included a front notch assumed to make aiming easier for men.[279] To wipe themselves, people used straw, old rags, or a type of absorbent moss which was

Figure 53: Moss "Toilet Paper"
Uncovered in a waterlogged area of the excavation at Whithorn, Scotland
(http://www.futuremuseum.co.uk)

purchased from vendors in the city known as *mangones* (Fig. 53).[280] After completing their business it does not appear that anyone scrubbed their hands, something which no doubt contributed to the spread of disease and intestinal parasites.[281] Beneath the area where people

[279] Cembrzyński, *Zaopatrzenie w wode*, 68.
[280] Records show that such vendors also made regular deliveries to the royal court. Dembinska, *Food and Drink in Medieval Poland, 53.*
[281] Intestinal parasites, most often spread through contact with infected feces, were a problem amongst all strata of society in the middle ages. For more information on the topic see: Piers D Mitchell, "Human Parasites in Medieval Europe: Lifestyle, Sanitation and Medical Treatment," *Advances in Parasitology* 90 (2015): 9-34. Such parasites as well as other infections would have been far more easily spread before the advent of hand washing. Hand washing with soap is today so ubiquitous that its importance is often underappreciated. Washing hands after using the bathroom is considered by the U.S. Center for Disease Control to: reduce the number of people who get sick with diarrhea by 31%, reduce diarrheal illness in people with weakened immune systems by 58%, and reduce respiratory illnesses, like colds, in the general population by 16-21%."Show Me the Science - Why Wash Your Hands? | Handwashing | CDC," accessed April 21, 2016, http://www.cdc.gov/handwashing/why-handwashing.html.

sat, lay the cesspit (Fig. 54). If these were lined, and not merely a large hole, they were

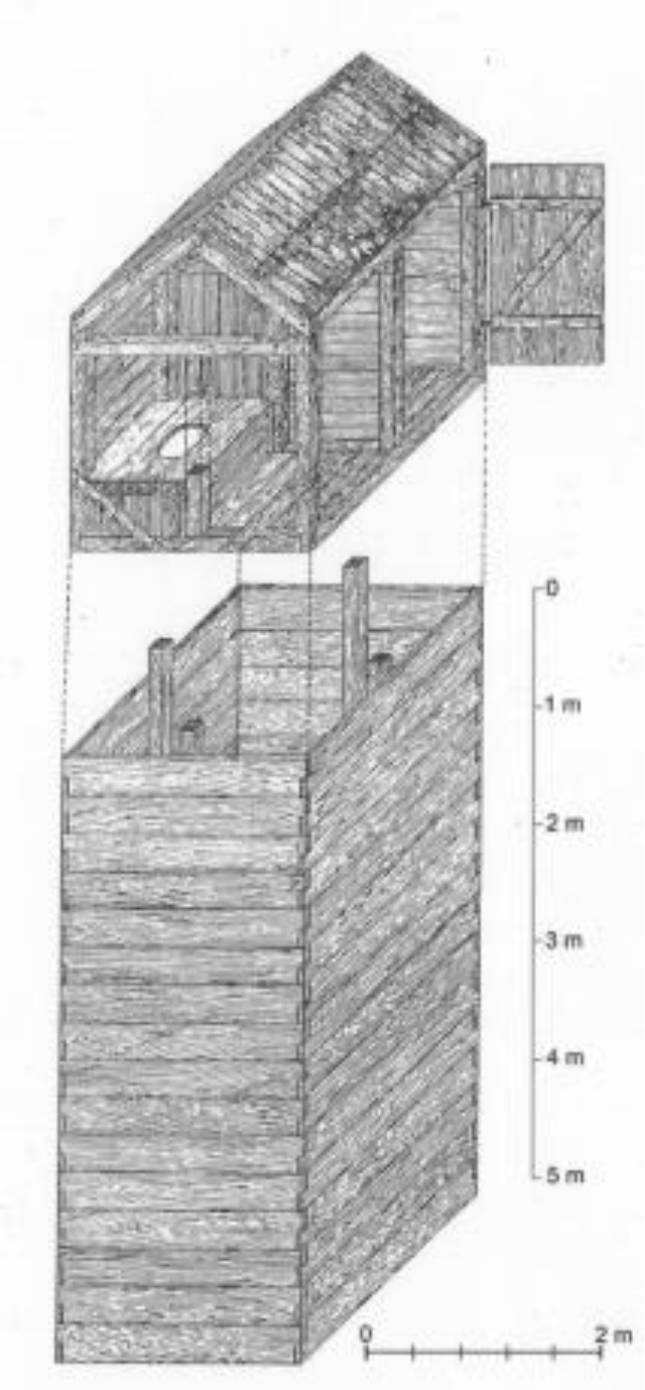

Figure 54: Krakow Cesspit Trial Reconstruction
24 Globia Street, Krakow
(Piekalski, Prague, Wrocław and Krakow: Public and Private Space at the Time of the Medieval Transition,151)

framed in wood or even reused barrels. This wooden shaft was then often further surrounded with clean sand or encased in clay which acted as a shield or filter, keeping the contents from leaking out to contaminate the rest of the environment. [282] Water wells, which were located

[282]Latrines uncovered in Poland and the Baltic have generally been lined with wood, significant numbers of stone and brick lined latrines have been found only in Eblag, while reused barrels have been uncovered across the region. Cembrzyński, *Zaopatrzenie w wode*, 72–3, 77.

toward the front of the plot in an effort to avoid leakage from the latrine, were regularly lined in the same way offering a double layer of filtering protection for the water supply.[283] This practice shows that residents had some conception that drinking water should be protected from contamination.[284] However, despite this insight, expediency often meant that cesspits were dug randomly in the back-garden, left unlined, and the privy simply moved to the next location once it was full with little care given to the dangers of groundwater contamination. Perhaps in part because of this tendency, there were civic regulations governing boundary lines and privies, although otherwise the city rarely showed an interest in attempting to regulate what residents did within their own household plots.

The law dictated that latrines had to be enclosed and located at least a meter from a neighbor's plot.[285] Indeed, records show that the Dominican Chapter in Krakow brought just such a case forward when their neighbor built a cesspit too close to the property line. [286] Not every family however, was lucky enough to have their own individual latrine, quite often these necessaries were shared by many living in townhouses.[287] Other cities required that every homeowner provide a privy for tenants but this was not the case in Krakow.[288] There is also little evidence to be found regarding the cleaning out of cesspits by night-soil men. Still, notwithstanding the lack of textural sources, it is very likely that regular clean-outs occurred as part of the reason for lining pits to begin with was to make them easier to dig out, once the

[283] Ibid.
[284] Due to its lack of intermural tributaries, the city did not have the common *garderobe* style latrines which jutted out from houses over the waterway, thus allowing muck to splash down and be swept away by the current below. These may have existed as part of the city walls bastions to be used by the few men on watch but given the walls destruction in the nineteenth century it is now difficult to say.
[285] Book II. 51 *The Saxon Mirror*, 108.
[286] Cembrzyński, *Zaopatrzenie w wode, 79.*
[287] Still in the seventeenth century, residents of a townhouse, if more than one family shared the residence would split the cost of building a new privy and other home repairs. Kamila Follprecht, "Buildings and Dwelling of Krakow in XVI-XVII Century: Descriptions Contained in the City Deeds," *Geology, Geophysics and Environment* 40, no. 2 (2014), 187.
[288] Nicholas, *The Later Medieval City: 1300-1500*, 332–33.

muck reached the top.[289]

Figure 55: Swaddled Baby Jesus
Detail from, *"The Flight into Egypt"*, Master of the Dominican Passion, c. 1460, National Museum, Krakow (http://artyzm.com/e_obraz.php?id=2212)

Adults however, were not the only ones needing to relieve themselves, and babies and children required special consideration. Prior to the sixteenth century, babies in Europe do not appear to have worn diapers. Little ones were instead tightly swaddled in bands of cloth for their first few months up to a year. The practice believed to help firm up the soft body of

[289]Ibid. Cesspits came in various sizes, the larger they were, the less often they needed to be cleaned. A spectacular example comes from two Nuremburg merchants, Tucher and Bhain whose 30 meter cesspit required cleaning only every thirty years, but more normal sized pits might need digging out every one or two. Unlined pits were simply covered over when they reached capacity, a new hole was dug nearby and the latrine moved there. Over time however, especially as cities became more crowded, this system became untenable and lined, cleanable cesspits more common. For examples of latrine cleaning from England see Dave Evans. "A Good Riddance of Bad Rubbish? Scatological Musings on Rubbish Disposal and the Handling of 'Filth' in Medieval and Early Post-Medieval Towns," in *Exchanging Medieval Material Culture: Studies on Archaeology and History Presented to Frans Verhaeghe*, ed. Koen De Groote and Frans Verhaeghe (Brussel: Vlaams Instituut voor het Onroerend Erfgoed, 2010), 272-75.

the child as it kept it warm and made it easier for mothers to carry with them.(Fig.55)[290] The modern German word for diaper can be traced back to this practice, as *windel* originally applied to wound swaddling clothes. These wrappings acted in place of diapers, soaking up anything emitted by the child. Once dirtied, they could be unwound and washed in wooden tubs.[291]

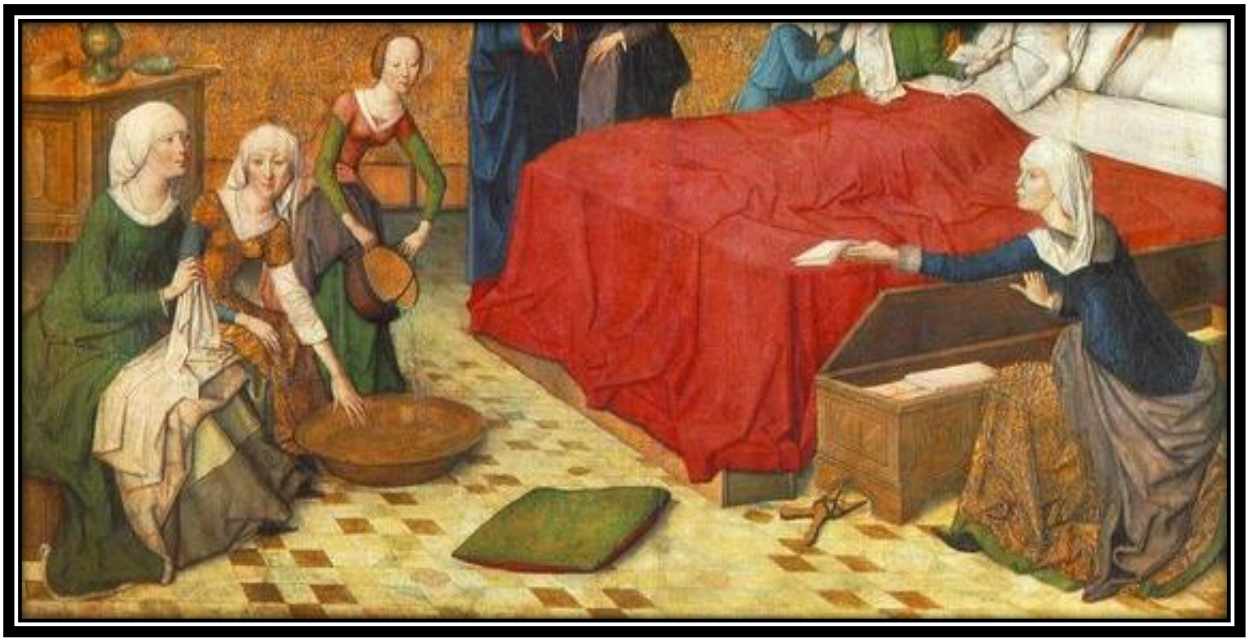

Figure 56: Detail Showing napkins and linens
Detail from the Birth of the Virgin by the Master of the Life of the Virgin, German, 1470 (Wikimedia Commons https://en.wikipedia.org/wiki/Master_of_the_Life_of_the_Virgin#/media/File:Meister_des_Marienlebens_005.jpg)

[290] Ethnographic studies in Russia in the nineteenth century had mothers swaddling their babies for a full twelfth months. Paul B. Newman, *Growing Up in the Middle Ages* (Jefferson, N.C.: McFarland, 2007), 66.
[291] Ibid.

As images show, these *windel* or *napkins* which also evolved into the British term nappy, were very common household articles and used both for babies as well as hand cloths (Fig. 56). Once loosened from their swaddles, toddlers were permitted to roam about naked or in a loose smock without underwear. These children, not yet potty trained, might go whenever and wherever nature called them. Indeed, the humorous Behem codex artist seems to imply this very fact of life as what appears to be a large turd lies next to the naked baby seated by his mother in the cobbler's guild miniature (Fig. 57).

Figure 57: Mother and baby with a turd.
(Detail from: Guild of the *trzewikarze* (boot-makers) *czyli* (known as szewcy, cobblers)
Balthsar Behem Codex Folio

As children grew a bit older, they came in time to be potty trained; however evidence for medieval potty-training is very scant on the ground. What there is, points to children around the age of two being introduced to a type of "potty-seat" and encouraged to use this.[292] Such child-sized seats would be practical, given the height at which most latrine privy seats were set, and the size of the holes made in the privy seats, it may have been rather difficult for a young child to use them without assistance.

Privacy, evacuating ones bowls, and nudity were conceptualized very differently during the medieval period. The taboos of our own culture towards nudity and flagrant defecation can make it difficult to imagine how for the people of Krakow it was likely far less embarrassing to be seen urinating or defecating in public than we would imagine it. Children continued to wear undifferentiated gender-neutral smocks without underwear, indicating their de-sexualized status until the age of seven or eight, when traditionally boys in Poland were formally recognized as members of the clan. Up until this point, they would have been under very little compunction not to simply go where and when the need arose. The shame felt when emptying ones bowels in a public space is a learned response; it is not innate but rather culturally defined. Still today, in China and in many other parts of the world babies bottoms are left bare and it is considered in no way strange for children to urinate or defecate on the street or in public areas, the same holding for a large extent as well for adults. The people living in medieval Krakow were very likely similarly blasé about such public exposure and did not stigmatize defecation or fear public nudity to the same extent that we do today. People bathed communally and double-latrines or entire rows of privies where one would sit literally cheek to cheek are not unknown. How different from our own need for secret

[292] The example comes from late thirteenth.- early fourteenth-century Italy and a treatise on childcare written by Francesco da Barberino. Newman, *Growing Up in the Middle Ages*, 66–67.

separated stalls, particularly for women, wherein the very sound of another relieving themselves can provoke a torrent of embarrassment.[293]

Yet, simply as a matter of practicality, in should be recalled that Krakow seemingly had no public latrines and even private privies were not common to every household, people had to go somewhere and that place was often de facto public. Without the ubiquitous bathrooms modern society enjoys or even the basic set of public privies common to the other medieval cities, they could do little else.[294] Thus the high propensity of human fecal matter found spread across the city even in such prestigious sites as the main market square, points to a relaxed attitude toward public relief.[295]

Conclusion

The wastes present in medieval Krakow were those common to any pre-modern city: animal droppings, human feces, heavy metal laden smoke, tanners' smelly liquids and other industrial pollutants. This overflow of unpalatable but undeniable bi-products is a fact of all urban places both medieval and modern and is something all cities must find ways to deal with. Many of these leavings that we today would considered pure "waste" were recycled to a purpose within the city. Urine, was useful to both tanners and in bleacheries, manure might

[293] As an example of the opposite cultural extreme, in Japan in particular, the sounds people make when they use the toilet are considered highly embarrassing, particularly by women. Japanese women would thus flush the toilet twice in order to mask the sound of their use. Out of concern for water-waste during a drought, in 1988 the Toto company developed the *otohime* (sound princess), a device which emits the sound of a flushing toilet to mask other sounds. Today, portable versions and smart phone apps are available offering the same service. It is possible that this concern for the sound of public urination and a device designed to cover it dates as far back as the nineteenth century, where noblemen in Yakage might use a *Otokeshi-no Tsubo* (Urn for Covering the Sound). Yoshino Matsui, "Masking Toilet Noise May Date Back to Edo," *Japan Times*, February 11, 2010, accessed April 4, 2016. http://www.japantimes.co.jp/news/2010/02/11/national/masking-toilet-noise-may-date-back-to-edo/#.VwJSFPl97rd

[294] I have found nothing in the records to indicate that Krakow had public latrines.

[295] For descriptions of waste, excrement, and dung found in Krakow sites see: Jerzy Piekalski, *Prague, Wrocław and Krakow*,52; Tadeusz Sokolowski et al., "Changes of Natural Environment in Kraków Downtown: Its Chronology and Directions; Case Geoarchaeological Studies of Krupnicza Street Site," *Geochronometria: Journal on Methods & Applications of Absolute Chronology* 31 (May 2008): 17, doi:10.2478/v10003-008-0013-x. Aldona Mueller-Bieniek, Adam Walanus, and Emil Zaitz, "Cultivated Plants in Medieval Kraków," 104-5.

be collected for use as fertilizer, while fat and gristle could be transformed with ash into soap. Waste was perceived differently so many years ago. In the same way, the dangers of certain kinds of pollution were not obvious to people at the time. While foul vapors or strongly tasting waters would give a clue that something was amiss, insidious heavy metals and invisible bacteria were not recognized as clear and present dangers. Still, as the population of the city rose, the rubbish that was recognized as such at the time accumulated to such an extent that it demanded attention. The civic leaders of Krakow, however, failed in many places to adopt sufficient measures to combat these problems. While the city administrators encouraged residents to keep their section of the public roadways clear and succeeded in banning particularly noxious trades from operating within the city walls, Krakow's waste-legislation was insufficient, the enforcement of those limited statutes seemingly all but non-existent and the city's lack of organized services like garbage collection or public latrines. At the same time, the city's infrastructure was greatly improved between 1257 and 1500. Nearly all the streets were paved by the early fourteenth century and an impressive piped fresh water supply system with its fresh water intake placed upstream of the city's pollutants was installed in the later years of the same century along with a set of public and private gutter canals that helped flush wastes from homes. Private citizens meanwhile sought to minimize waste creation in order to maximize their own limited resources and some care was given to the building and placement of wells and latrines to ensure one did not contaminate the other. These measures helped, but the lack of sufficient civic engagement by the authorities, meant that Krakow remained a begrimed space much longer than its contemporary neighbors. The leaders of Krakow were either unaware of the management strategies like public trash collection or stringent cleaning codes being adopted by their neighbors or were too politically fragmented to put such actions into practice. Only in the

mid-sixteenth century would reforms spearheaded by the king promote major change. Ultimately, what did this mean for the people living in Krakow at the time?

The piling up of manure and feces within the city walls encouraged the spread of disease as they were breeding grounds for parasites and bacteria. As archeological analysis has shown, large sections of the city were contaminated with heavy metals from foundries which overtime would have affected residents health. As well, despite the careful placement of the *rurmus* water intake away from obvious sources of pollution, no system was perfect and if King Sigismund I is to be believed, by the early sixteenth century even here problems had begun to appear. The end result of all this was that living in the city was worse for your health than living in the countryside.[296] The concentration of wastes and pollutants within the walls of Krakow had a slow deteriorating effect upon the health of its population that could have been greatly relieved had better management practices, common to other cities, been put into place.

There is much more that could be said on the history of waste in Krakow. In this work I have touched only lightly on how pollution was perceived by the population. The medical side of this question, what ailments were understood at the time and how physicians sought to treat them is also a fruitful avenue as yet unexplored. Further research within the Krakow archives might also reveal greater efforts made by the civic authorities to manage the city's wastes than have so far come to light. A great deal more work also waits to be done on waste management in other Polish cities that will offer chances for further comparative assessment. Waste is a fact of human life, constant through time and yet often ignored because of its unpleasant nature. I hope that in this work I have shed a tiny bit more light into the deep historical cesspit waiting to be explored.

[296] Tracy K. Betsinger, "The Biological Consequences of Urbanization in Medieval Poland, " (Phd. Diss., Ohio State University, 2007), 251-54.

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