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UNDERSTANDING ROMAN SANITATION FROM ARCHAEOLOGY

TOILETS, SEWERS, AND WATER SYSTEMS

1. REASONS THAT TOILETS APPEARED AND PROLIFERATED IN ROMAN CITIES IN ITALY

Since public latrines are most frequently, although not exclusively, found in the context of public baths dating from the first century B.C. to the second century A.D., much of the scholarship on the popularity of Roman baths and bathing customs also relates to public latrines and their use. Unfortunately, little direct archaeological or textual evidence exists to explain the proliferation of bath buildings and the bathing habit, especially in the first period of growth, from ca. 100 B.C. down to the age of Augustus. The reasons we can speculate for the growing numbers of baths, however, also make good sense for comprehending the increasing numbers of public latrines,[1] so they are worth reviewing.

First of all, the Romans simply liked frequenting baths. As public latrines became ever more common in baths and within urban settings, we can only assume that they too were becoming more and more popular, although the clients inside dark, dank latrines may not have enjoyed remaining inside them for as long as they were willing to linger in the various rooms of bathing complexes. The increasing frequency of toilet services in cities, however, was becoming a part of Roman cultural identity, as baths were as well. Urban inhabitants of any social station certainly would have noticed over time that urban planners were devoting more and more space to such public facilities in their cities, especially for activities such as bathing and body cleansing, so more and more people got accustomed to them and expected to see them. The case studies in chapter 1 confirm such trends.

Second, the existence of baths and public latrines in Roman cities, particularly from the time of Augustus, is very likely connected to the social *mos* (custom) of open, communal living for an ever-expanding urban population. In the city of Rome itself, squalor was everywhere, of course, and the desire to escape it probably never ceased. Even if such squalor was regarded as a part of the normal surroundings, especially for the urban poor, it must have been debilitating and depressing. Baths and toilets were certainly not constructed, however, because of any pressure from the poor on account of their expectations for cleaner surroundings. Poor people suffering in small, dirty apartments in Roman cities had little say about anything happening around them. The authorities who built baths and toilets, however, would no doubt have appreciated the political coinage to be gained from the situation by adding such amenities to the urban landscape, even if they did not care specifically about what happened to the urban poor in the long run.

Third, simultaneous improvements in Roman building technology also would have contributed to the building of baths and latrines in cities. Developments specifically related to the manufacture of more durable concrete (*opus caementicium*) allowed for increasingly larger, more elaborately designed, and more long-lasting structures.[2] The fourth and perhaps most important reason for explaining the spread of baths and latrines in the cities of Roman Italy relates to the influences of trade and travel. Trade and travel are most often the mechanisms for technology transfers, which we consider below in the next section.

Before closely pondering the evidence in Roman Italy, however, I must be clear here that public toilets were not an isolated phenomenon that appeared solely in the Roman period. Sanitary facilities, including public lavatories, stand in a long tradition going back as far as the third millennium B.C. to Mesopotamia (Mari, Ur, Akkad) and Egypt (Tell el Amarna).[3] Scholars have argued that latrine architecture was introduced into the Greek world, by way of Crete, via northern Siberia (Zincirli, Alalakh), and by various trade routes into the Mediterranean region generally.[4] Even though the physical evidence for such a speculation is extremely thin, the development and dating of latrine provisions has been traced by the conformity of designs and similarities in technical characteristics.[5]

While I shall not discuss these early sanitary facilities further,[6] we need to bear in mind that from the sixth to the fourth century B.C. and especially in the third and second century B.C., public toilets began to appear in a variety of Greek cities. We have notable evidence in Athens, Delos, Kos, Olynthus, and Priene.[7] Public sanitary facilities in Roman Italy began to flourish from the sec-

ond century B.C. and afterward in a fairly wide variety of settings: towns, "rest stations" along isolated highways, spas, and military camps on the expanding Roman border frontiers, and even in far-flung colonies, although the quality of the ruins varies considerably from site to site. Examples of public latrines in Roman Italy, Western Europe—including England, France, the Netherlands, Germany, and Switzerland[8]—North Africa, Asia Minor, and the Near East are quite well preserved and plentiful from the middle of the first to the third centuries A.D. By one estimate, at least 250 separate Roman public toilet structures of various dates and styles can be seen all across and around the Mediterranean.[9] I think this number is greatly underestimated, possibly by thousands rather than hundreds.

2. TRANSFER OF LATRINE TECHNOLOGY IN THE MEDITERRANEAN

The new research on toilets and toilet use in the ancient Near East and in Greece mentioned above certainly demonstrates that the idea of public toilets did not originate with the Romans. External factors that may have had some bearing on the growing popularity of latrine facilities in Roman Italy exist, but are hard to prove. Over the years, scholars have considered that the architectural form of public latrines either came from the ideologies of the Roman ruling classes or from the Roman army, but now significant evidence in the archaeological record points to the cities of the Hellenistic East as the principle source. Still, we must wonder, if this architectural form did come from foreign soil to Italy, how was it transmitted and how was it transformed, if at all, once it arrived?

Technological and social questions are closely linked, especially in the area of water use and supply. Scholars have argued that engineering approaches to purely technological issues concerning water use and distribution—flow-modeling calculations; investigations of engineering principles for structures using water; analysis of mortars in aqueducts, baths, toilets, and the like—are the only way to yield productive research conclusions.[10] Answers to technological problems or specific engineering issues can certainly explain why a particular design solution was adopted in a particular latrine construction. I, however, remain equally committed to examination of the social questions connected to both water and toilet research. As the history of technology is ultimately an inquiry into how and why a society, ancient or otherwise, utilized technology—whether for prestige, for needs of particular users, for political power, or to gratify new social impulses—nontechnological issues, such as the availability of public finances, cultural trends, or changing societal

ideals, can also play a role in particular design results for all kinds of structures, including latrines.

The old idea, then, that the Roman army marched out of Italy and spread latrine culture across the Mediterranean lands it conquered is no longer viable.[11] The Romans absorbed Greek culture over a period that spanned several centuries. The process by which Roman Italy became Hellenized, however, is not so easily grasped, although Greek influence seems to have affected countless aspects of Roman life and society.[12] In a perusal of Greek toilets, we do not need to go back as far as Heracles and the Augean stables of mythology[13] to find the first excrement flushed with water in order to recognize Greek influence on Roman toilet design. As we shall see below, however, the Romans expanded upon the original Greek toilet form, tweaked its particulars, and disseminated it widely in their cities.

While the literary testimony for Greek toilets and toilet customs from the sixth to the fourth century B.C. is extremely rare, problematic, and out of the bounds we have set for this book, we must turn briefly to some of the Greek archaeological remains to understand just what it was the Romans adopted from Greek toilet structures and from their customs.[14] We start at the late Hellenistic site on the island of Thera. There, a latrine was found near the agora.[15] Because it accommodated about eight persons and was attached to a market hall, we can safely assume that it was installed for communal use. The excavation report shows, however, that all the other toilets found on Thera were built into private houses, though some of these seated three people and had direct access from the street.[16] The market-hall latrine itself was a dark and, from our perspective, grim room, despite the marble slabs that decorated its floor. The only light source for the latrine came from the door, and it appears that no supply of fresh water serviced the facility. A similarly modest public arrangement has been found on Amorgos, also Hellenistic in date.[17]

Some of our best evidence for the growing emergence of public toilet installations in the Hellenistic world comes from Delos,[18] where a number of publicly accessible latrines have been discovered. In addition to the larger, completely public facilities, toilets were fitted in several private houses on Delos in small rooms near their vestibules (separate rooms with no direct access to the house itself), which could therefore be accessed by passersby as well as by inhabitants of the house. Again, it is beyond the limits of this inquiry to study these and other Hellenistic toilets in any detail here, but their presence sets an important precedent for Roman Italy. Many Roman merchants would have traveled to Greece or to the colonies of Magna Graecia in southern Italy and observed such facilities in these trading ports and in their dealings in

the various agorae. However unpleasant or crowded the latrines might have been to use,[19] these latrines would have offered the Romans a kind of vision for a potentially cleaner and more convenient city, an innovation that might be worth bringing back to Roman Italy. Even though Roman eyes had certainly seen such Hellenistic facilities by the second century B.C., and perhaps much earlier, I am not at all implying that they suddenly caused a revolution in Roman urban hygiene. Instead, these toilets likely provided the inspirational spark that eventually brought the public latrine into close proximity with the Roman *macellum* and ultimately closer to other public buildings (fora, theaters, amphitheaters, temples), as we saw clearly both at Pompeii and at Puteoli. Of course, the Romans could have decided on their own to situate toilets in places where crowds gathered, but they were also adopting ideas from Hellenistic cities, and this could have been one of them.

No such public toilets are known in Italian cities of the late republic, although this absence does not necessarily argue fairly against their existence. They may have simply vanished in the course of time, since such structures were often made of wood that has not survived.[20] The mention of latrines in Roman comedy proves only that they were an understandable concept to the Romans, and not their existence in the real urban landscape at this early date. The assumption that there were latrines at this early date, however, is both tempting and highly feasible.[21] As early as 161 B.C., according to one Roman writer, we learn that simple urinals were available in the Roman Forum.[22] Once latrines were a fixture in the Roman marketplace, the stage was set to utilize them in other settings in the city with an increasing realization of their potential to confine the somewhat distasteful human activities of moving the bowels and urinating to specific places. In the hands of the Romans the construction of toilets most certainly evolved in cities, and we must also consider the reasons for that transformation and how it was brought about.

The increasing draw of *luxuria* (luxury) in Roman culture, both in public and private domains, during the first century B.C. seems to provide the backdrop for the Roman public bathing habit, so it likely affected the public toilet habit to some extent as well. In their lust for *luxuria* men sought to acquire multiple private properties equipped with every amenity and were not averse also to investing their wealth in extravagant and ostentatious public constructions.[23] Seneca was convinced of the evils of *luxuria* as he moralized on new bathing amenities. He complained of costly, resplendent mirrors, marbles from Alexandria, and mosaics of Numidian stone.[24] From the time of Augustus into the second century A.D., a visit to the baths meant that one was

ever more enveloped by *voluptas*, the pure pleasure of comfortable surroundings.[25] Roman moralists had long attributed the influx of luxury into Italy to the Roman army's contact with Asia Minor. Sallust[26] tells us, "Besides all this, Lucius Sulla, in order to secure the loyalty of his army which he led to Asia, had allowed a luxury and license foreign to the manners of our forefathers; and in the intervals of leisure [*otium*] those charming and voluptuous lands had easily demoralized the warlike spirit of his soldiers. Asia Minor was where an army of Roman people first learned to indulge in women and drink; to admire statues, paintings, and engraved vases; to steal them from private houses and public places; to pillage shrines; and to desecrate everything, both sacred and profane."

Livy also points an accusatory finger at Asia Minor as the source of all extravagance, hence degradation, for the Romans. Toilets are not anywhere specifically mentioned, but they do fall under the amenities provided by fancy bathing facilities, definitely a luxury trend from the East. In speaking of Gnaeus Manlius's triumph in 187 B.C., Livy says: "The germ of foreign luxury was brought to Rome by the army from Asia Minor."[27] Can these literary claims be verified with any direct archaeological evidence for how the army might have brought back a taste for eastern *luxuria* to Roman Italy?[28]

While the archaeological evidence is rather slim for determining Hellenistic influence in Rome, the Roman colonists of Pompeii, veterans for the most part, who settled there in the 80s B.C. clearly imposed their new taste for self-promotion, new wealth, and showy cultural aspirations on the town.[29] They brought several new constructions to Pompeii: a refurbished Capitolium, an amphitheater, residential construction on top of the old city wall, many lavish new tombs, and handsome baths and toilets, both public and private. Also in this period between 80 and 55 B.C., Pompeii's Forum Baths (VII.5.2.7–8, 10, 12, 24) were built,[30] a gift to the population from the local council, with the magistrates L. Caesius, C. Occius, and L. Niraemius overseeing the work.

City authorities, however, were not the only ones building baths and latrines at Pompeii. Especially in the final years of the city, private entrepreneurs were also adding new buildings and new amenities. Three other complexes—the Palaestra/Sarno Baths (VIII.2.17–23),[31] the Suburban Baths,[32] and the Praedia of Julia Felix (II.4.1–12)[33]—of a semiprivate nature were privately built a hundred years or so after Pompeii had become a colony. The Republican Baths of Region VIII (VIII.5.36),[34] dating to the late second century or early first century B.C., were also privately built. At least one or two additional public or semiprivate baths, those of M. Crassus Frugi and of Agrippa, are known only

from inscriptions.[35] Apart from the final two baths, all of the surviving baths mentioned above, as we saw in chapter 1, had latrines either in or attached to them.

The archaeological evidence from Pompeii and other cities suggests that the idea for latrines was transmitted into Roman Italy by Hellenistic cultural forces, which, in part at least, had influenced the returning Roman army, and accordingly changed the urban landscapes of the cities, such as Pompeii, in which the old soldiers eventually settled. Partly because latrines and bathing facilities were constructed in Roman military camps that were built ever deeper in the barbarian hinterland, the notion that Roman soldiers insisted on such amenities for the care of their bodies and therefore spread their customs across Europe in all directions from Italian origins has been hard to put to rest. The startling fact is that almost all of the latrine evidence from Roman military camps postdates the Hellenistic period, when toilets were already being constructed in the cities of Roman Italy.

A brief digression to a far-flung Roman military camp on the frontiers with its latrine facilities still intact can perhaps help clarify my point about the complexity of technology transfer. Some important information about latrines and their use comes from a magisterial study[36] of Roman military barracks from the first to the third centuries A.D. in Britannia, Germania Superior, and Raetia.[37] The British researchers detailed the dimensions and identifiable areas of legionary barracks, noncohort barracks, auxiliary barracks, fortlet barracks, and garrisons. In turn, they also described and analyzed the centurions' quarters, men's quarters, the relationship between the two, petty officers' quarters, and *contubernia* (tent camps). They outlined construction (standard units of measurement, site preparation, techniques, roofing, flooring, doors, and windows) and amenities (hearths, latrines, washing facilities, storage and rubbish pits, furnishings, and wall paintings). The Augustan and Tiberian periods are the earliest covered. It becomes immediately clear that few barracks survive from the earliest periods, and distinctions between legionary and auxiliary barracks are not easily made.[38]

Nevertheless, even for these earliest barracks, a characteristic set of design principles for latrines was in play that was to be maintained through the next three centuries.[39] The largest and best-preserved Roman military camps located throughout the Roman Empire are Trajanic and later.[40] The archaeology tells me, therefore, that the Roman soldiers who built these barracks brought the technology with them, which they already knew well from the cities of Roman Italy. By the first century B.C., and probably much earlier, the cities of Roman Italy had already learned latrine technology well from the Hel-

lenistic East (as we saw above) and transformed it for their own Roman urban-planning needs. By the time soldiers were constructing these northern barracks in the first century A.D., latrine construction designs had been informed by the designs of toilets within Roman cities, which themselves were informed by those of the Hellenistic East.

Of special interest to observe here is the fact that officers' quarters in legionary barracks often had their own small latrines, which were usually placed in one of the small rooms at the end of the quarters in order to have access to fortress or fort drains running past the ends of the barracks. In smaller rooms of the centurions' quarters in several legionary barracks, a tiled floor slopes steeply in the direction of a small drain, which implies a latrine installation. Latrines for the officers were often associated with washing facilities, which were arranged so as to provide flushing water.[41] We cannot identify this kind of latrine hierarchy in the Hellenistic examples.

Auxiliary forts were usually not provided with such elaborate drainage systems, and therefore featured cesspits instead. Barrack I at Hod Hill, for example, was equipped with a cesspit latrine just to the south of the barracks.[42] Even when a central drainage system was in place in an auxiliary fort, soak-away cesspit latrines were preferred when the subsoil was suitable.[43] While latrines were often in or near the officers' quarters, they could be placed far away as well. A large latrine pit was placed at the *contubernium* (military camp, usually consisting of tent dwellings where soldiers lived together) of the more northerly barracks at Exeter Goldsmith Street. This latrine, on the one hand, could have served for the whole century.[44] On the other hand, some latrines served only a single *contubernium*. The timber boarding and clay lining of some of these pits would mean that liquids could not readily soak away.[45] In any event, the solids would have piled up. The use of buckets has been suggested for emptying these pits at the Lunt. Direct evidence to confirm this method of cesspit clearance is almost nonexistent, but we do have one somewhat promising entry in a duty roster of Legio III Cyrenaica for the first ten days of October, between A.D. 90 and 96. The name M. Longinus is specifically connected with *stercus* (excrement), so perhaps he had the job of cleaning out the latrines (or possibly stables) or of removing excrement from the streets.[46] For the duty roster to mention *stercus* for this soldier definitely suggests a lowly, undesirable, and probably part-time, although rotating, job.

Latrines in barracks did not always just manage solids. A number of amphora latrines filled with fist-size cobbles have been found in various barracks, as well as the occasional "eavesdrip-channel" latrine.[47] The overwhelming impression gleaned from this evidence is that the officers were the ones who were

favored with latrines and washing facilities, and therefore water supply, and this is so from the earliest examples we have. Latrine constructions in military settings were for those soldiers of higher status, not the common soldiers. We may surmise from this that Roman soldiers possessed the technology for building latrines in the second to first centuries B.C., and maybe much earlier, most probably from early technology transfers from the Hellenistic East to the cities of Roman Italy, or directly from the Greek colonies of southern Italy and from Greek sites in the Aegean.

Ascertaining the main inspiration for Roman toilets, if one source is even reasonable to assume, continues to prove difficult. The matter is further complicated by the fact that new studies of the toilets and public latrines in cities like Pella, Pergamon, Delos, and other Greek cities in western locations, such as those in southern Italy or Sicily, show that toilet distribution and design (including the length of sewer canals, spacing for seats, flushing provisions, availability of water and basins, and general functionality) varied enormously from city to city.[48] If the Greek latrine was an invention of the Hellenistic koine, whatever kinds of Hellenistic toilets Roman soldiers and traders were seeing and experiencing, they did not, apparently, bring back specific toilet design features to Italy. I am arguing, therefore, that those soldiers who had served in the East may have been influenced by the *luxuria* of baths and toilets they saw there (even with their varied design features) and, upon their return to Italy, they may have contributed their ideas to the design of the facilities constructed in the Roman cities where they settled. At the same time that ideas for latrine constructions were filtering to the West from the Hellenistic East through military connections, from trade, and from travelers, toilet designs in the West were being combined with an established military latrine culture, and that culture was moving out of Italy to many far-reaching hinterlands with the construction of military barracks.

Dutch scholars have been studying the military camps of Nijmegen (Holland), Utrecht, Valkenburg (in the province of Zuid-Holland), and Alphen aan den Rijn (Roman Albaniana) with a distinct concentration on questions of water supply and available facilities.[49] Their striking discoveries militate against any notion of latrines for the common soldiers in military camps as luxurious, hygienic strongholds. For example, the existence of only two latrine sites identified at the fort in Nijmegen indicates that each was intended for about one thousand soldiers. Such a discovery also helps us understand why military officers would have insisted on smaller, more private latrine constructions in their own quarters.[50] Water pipes, sewers, and lavatories in military camps certainly deserve more attention,[51] but they are beyond the scope of this book.

My main concern is to seek the roots of a Roman latrine culture in the earliest context possible in Italy. If we ask where the armies of the republic and early empire were billeted in the late first centuries B.C. and A.D., archaeology largely fails us,[52] but early historical sources give us some information. While military camps were constructed for the army at large, in the heroic days of the Roman forefathers, Rome had a very practical and economical way of dealing with care of the army. Livy tells us, for example, that in 480 B.C., after a victory over the Etruscans, the consul Manlius, remembering "that policy which he had adopted in the beginnings of his consulship, of winning the affections of the plebs . . . billeted the wounded soldiers on the patricians, to be cared for. To the Fabii [a prominent Roman family] he assigned the largest number, nor did they anywhere receive greater attention."[53] Livy points out that this was a good political investment.[54] After another battle, even enemies were "quartered among the citizens . . . until their wounds were healed."[55] While these references are admittedly for the quartering of wounded soldiers, the quartering of the regular army among civilians surely also occurred frequently during the late republic and the empire, especially when the battles were in the territories of Roman Italy.

Starting in the early empire, Roman military camps became more and more systematized, regularly incorporating multiseat latrines, and including special areas for the sick and wounded called *valetudinaria*,[56] the forerunners of our hospitals. Such developments are a fascinating chapter in Roman social and architectural history. From the information we have explored, it seems quite clear that the architectural design and placement of latrines in military camps resulted from the general dissemination of latrine culture—already well established in the cities of Roman Italy, as we see it manifested from the late republic onward—rather than the cause of latrine construction and use for the civilian population.

Given the way technologies are transferred, I believe that the city of Rome itself was probably the center of the developments that led to increased construction of latrines and toilets in other cities of the Roman Empire.[57] While toilet design and construction were pretty standard for almost two hundred years of Roman rule, some small changes and advances introduced in the design of toilets were possibly technological transfers from other places. We examined the evidence for toilets in the city of Rome in chapter 1. It is essential to remember that technological change can be circular, moving out, around, and back again to an original source. While Rome may well have been a master teacher to the surrounding provinces in matters of Roman toilet technology and design, the city was also a pupil of its subject provinces and races in many

areas of technological development. In other words, the cultural forces that led to further construction and development of baths, latrines, and toilets in cities and towns throughout Italy were not always internally motivated only from Rome itself.

At the same time that Romans were trading with and traveling to the eastern Mediterranean and bringing back new ideas for the design of their cities, Hellenistic Greek city dwellers were moving about as well and, in turn, settling in Roman Italy. When this new ethnic population arrived in Rome, the newcomers, especially the rich among them, would have desired to establish their familiar urban institutions from the East in their new, adopted homes in the West.[58] The scope of acculturation of Greek taste in the Roman world must not be thought to be limited only to the practices of the Roman elite. Fairly recent work on cultural developments in the private spheres of urban and suburban life, especially at Pompeii, can also help us understand these trends.[59]

The origins of the republican villa from its opulent Hellenistic models, for example, show how the villa's enclosure of nature, especially represented by elaborate peristyle gardens, became a symbol of wealth and leisure for Romans at all levels of society under the empire. Detailed investigations of several important houses at Pompeii,[60] and in particular their gardens, which created the illusion of miniature rural villas within the town, support the argument that domestic taste was significantly shaped by political climate and cultural identity. Increasingly more sophisticated ways of using water allowed for the insertion of luxurious gardens and baths, often with latrines, within the private sphere. Houses such as those of the Faun (VI.12.1–8), Apollo (VI.7.23), and Meleager (VI.9.2.13), to name a few houses of Region VI, among many others elsewhere in the city, prove this point. Just as more public toilets and newer baths were appearing in the urban center of Pompeii, wealthy citizens, with the post-Augustan water supply at their disposal, were constructing more private toilets and baths within their own houses.

The same pattern we saw for the construction of latrines in military barracks (with multiseat latrines for the general population and smaller, single-seat arrangements for the officers) repeats in urban planning. The question of why the numbers of baths and latrines continued to increase in the cities of Roman Italy cannot be settled on the strength of any one of the reasons we have discussed above, but when the reasons are taken collectively, they do make a significant impact on our understanding of why Roman latrines (with features that were distinctively Roman) became ever more embedded in the urban designs of Italian cities.[61] Connecting latrines to an ideal of improved urban sanitation, however, is even more difficult than pinning down questions

concerning their origins and increasing numbers over time, so we now need to consider urban infrastructure for latrines, namely sewer systems.

3. The Cloaca Maxima in Rome and Misconceptions about Its Contribution to Sanitation

We must constantly bear in mind that the Romans were operating under their own religious, social, and political ideologies as they designed and outfitted their cities.[62] The great Augustan architect, Vitruvius, for example, offers very little advice about sanitary conditions and facilities in Rome, but he has much to say about siting villas[63] and keeping domestic water supplies pure in the countryside.[64] Specifically on the subject of public latrines and sewers, however, he remains discreetly silent. He does state that architects must be acquainted with *iura cloacarum*,[65] "the laws, or the rights, of the sewers," but he never explains exactly what he means by this or what these *iura* are. Perhaps more surprisingly, he never describes the construction of any sewer, let alone the Cloaca Maxima, Rome's Great Sewer (figs. 86–88), which was a substantial work of architecture in his day.[66] His audience did not consist of public-health engineers, but primarily of Roman aristocrats, whose sensitivities he was no doubt considering. Waste disposal and sewers would not have been of major interest to them.

Dionysius of Halicarnassus, writing at the time of Augustus in the late first century B.C., mentions Rome's sewers as one of the most magnificent constructions of Tarquinius Priscus. In fact, he measures the greatness of the Roman Empire of his day by the sewers, along with Rome's aqueducts and paved roads. Dionysius specifically notes that the purpose of the sewers was to lead excess water from the streets into the Tiber.[67] He also takes the trouble to cite the authority of Gaius Acilius, a senator of the second century B.C., who wrote a history of Rome in Greek, observing that "when the sewers had been neglected and were no longer passable for the water, the censors let out the cleaning and repairing of them at a thousand talents." Dionysius is just as impressed with the "usefulness of the work" as with the magnitude of the cost of building and maintaining the sewers. I take his point to be that there is profit in manipulating water, so no cost is too extreme.

Strabo, the Greek geographer (64/63 B.C.–ca. A.D. 24) quite probably himself a Roman citizen living also in Rome at the time of the emperor Augustus,[68] attempts to diminish the accomplishments of Greek city planners by insisting that the Romans employed greater prudence in their urban planning. He bases his praise for the Romans on the fact that they paid attention to matters he says

were largely ignored by the Greeks: paving roads, laying out aqueducts, and constructing sewers to wash away filth into the Tiber.[69] Strabo proudly states that the sewers were "vaulted with close-fitting stones . . . in some places . . . [with] room enough even for wagons loaded with hay to pass through them" and indicates that "veritable rivers" could flow through them. The capacity of the sewers to funnel vast amounts of water impresses Strabo above all else, even more than the dirt that the water moved away. Ultimately, of course, a large amount of sewage was also swept into the Tiber with this water. From this, we can now determine that another important function of the Cloaca Maxima was to control the flow of water through the city.

A passage in Pliny the Elder is even more explicit about connecting the sewers to water control.[70] Pliny recalls a time long ago when men really admired the ramparts (of the Servian Wall), the substructures of the Capitoline Hill, and especially the city sewers, the most noteworthy achievement of all. He tells us that seven rivers (*septem amnes*) used to flow through Rome, meeting in one channel. These, rushing downward like mountain streams, were constrained by the Cloaca Maxima and its branches, which in turn prevented the rivers' torrents from sweeping away everything in their paths. A new study catalogs at least thirty-two floods in ancient Rome documented by ancient sources between 414 B.C. and A.D. 398. Each one had its own special character and its own destructive force.[71] The sewer originally drained the valleys between the Esquiline, the Viminal, and the Quirinal, carrying surplus water along the Argiletum and across the Forum and the Velabrum to the Tiber.

When additional volumes of rainwater swelled these rivers, the overflow battered the bottom and sides of the sewers with unrelenting force. Even so, Pliny asserts, the unyielding strength of the fabric of the sewers resisted the strain. He says that sometimes the backwash of the Tiber made its way upstream along the sewers and could flood them. He marvels that falling buildings, which collapsed of their own accord or burned down with considerable frequency in Rome, and even earthquake tremors, had never seriously damaged the sewers for seven hundred years from the time of Tarquinius Priscus.

The actual remains of the Cloaca Maxima, where it is accessible, easily substantiate Pliny's claims. The triple-arched mouth of the Cloaca Maxima is still visible in an opening in the post-1877 embankment along the Tiber River (fig. 87). Pliny the Elder gives us another important insight: *praeterea cloacas, opus omnium dictu maximum, subfossis montibus atque, ut paullo ante retulimus, urbe pensili subterque navigata M. Agrippae in aedilitate post consulatum*. Pliny refers to various structures admired by men of earlier days, including, "furthermore, the city sewers, the most amazing work of all to speak about, since, as we

mentioned a little earlier, the hills were tunneled and the city of Rome became 'a hanging city,' beneath which Marcus Agrippa traveled by boat [possibly for inspections of the Cloaca Maxima] during his term as aedile, after he was consul."[72] This work on the sewer, especially the most aggressive improvements under Augustus, seems like a logical, direct response to some kind of comprehensive sanitary reform in Rome. Many later historians and romantics have viewed the Great Sewer in this manner. I am now convinced that this assessment is completely wrong.[73]

In the late first century A.D. Frontinus also provides his bit of cloacal fare in his great work on the aqueducts of Rome, *De aquis*, and his comment too is relevant for understanding the Roman view of the sewers, at least those in Rome itself. Frontinus defends the necessity of overflow from Rome's fountains and public basins "for the health of our city" (*ad urbis nostrae salubritatem*). Furthermore, he stresses the connection between water overflow and a healthy city rather than between a healthy city and its sewers. Water is the factor that brings cleanliness. Sewers merely contain water as it washes away muck, rubbish, and dirt for the sake of health, *salubritas*. Frontinus equates a healthy city with a place whose streets were regularly cleared of debris and filth into the sewers. His emphasis on water rather than the sewers is even clearer when he specifically states that excess water from overflows is necessary for flushing the city's sewers (*ad utilitatem cloacarum abluendarum*).[74]

Abundant water in the sewer channels would no doubt have helped clear the sewers from time to time. Even in winter, when rainfall in Rome is high, rarely would enough water have been available for a thorough flushing of all sewer channels. My own explorations in the Cloaca Maxima in recent years show that silt often built up to such an extent that many channels were completely filled from floor to ceiling in less than a year. Once I tried to enter the sewer behind the Church of Santa Maria in Cosmedin and found the silt completely blocking the entrance. In another expedition in a sewer channel under the Roman forum (about 2007), I found myself repeatedly tripping over piles of debris and silt as I tried to maneuver my heavy boots along the slippery ledge through muddy waters still draining into the sewer from modern streets. Frontinus, then, is likely describing an ideal cleaning strategy, not the actual situation.

Other archaeological evidence supports my skepticism. When the sewer under Cardo V at Herculaneum was first excavated in the 1930s, an ancient deposit of hardened sludge measuring about 1.35 m high was found on the sewer's bottom.[75] The Cardo V sewer was constructed under and just inside the outer wall of the *insula* above it and served, not as a drain to carry away waste material deposited from the toilets above it to the sea, but as a giant cesspit with

a firm closure at its southernmost point.[76] A second branch of this sewer, over 40 m long, cuts west under the Palaestra. As that branch had not been cleared in the earliest excavations, it afforded much valuable information to archaeologists both about nonorganic (broken storage jars, lamps, bronze vessels, coins, and jewelry) and organic material (fishbones, eggshells, pips and seeds, and fragments of different kinds of cloth) deposited there. The fact remains, then, that no amount of water, however fast flowing, would have been able to remove such a substantial buildup of debris.

Reading a serious concern for urban sanitation between the lines of Frontinus's comments is therefore inappropriate, in my opinion. He also says nothing specific about the construction or administration of the sewers. While his silence on these more technical matters is frustrating, it demonstrates the secondary place the sewers held in his discourse on the operation of latrines and urban infrastructure in general in Rome and elsewhere.

The Great Sewer undoubtedly did drain off into the Tiber excess street water, mud, animal dung, and other refuse that would have otherwise cluttered urban vistas, but I am unwilling to view it as part of a Roman sanitary revolution, despite the fact that the concept of "health" and the sewer are closely interrelated, as found in *De aquis*. A truly important interrelationship to note is that between water and its potential to clean, to refresh, and to inspire economic growth, urban development, and industry. The sewers did the job of moving stagnant and polluted water from where it was not wanted in the urban environment to someplace else. Another way to see this is to say that the sewer—assuming it was not hopelessly blocked—moved dirty water from where it hindered cleanliness, economic growth, development, and industry.

As Romanized cities spread across the Mediterranean, the hydraulic technology, time, and expense that were necessary to lay underground sewers surely rivaled the effort required for all other parts of the urban infrastructure, including construction of multistory apartment buildings, streets, and aqueducts. Just as networks of pipes were necessary for bringing clean water to fountains, public baths, and private houses, in many Roman cities sewer systems were there to take it away. Connections between these aquatic underground networks and concrete concepts of hygiene, as we would understand them, really do not exist. The most we can say is that the Romans seemed to define hygiene as the removal of visible dirt.[77] From this perspective, then, the sewer served a kind of hygienic purpose.

Since classical archaeologists have rarely concerned themselves either with sewers or public toilets, despite the impressive remains of these in Pompeii, Ostia, and Rome, overviews of daily life and topographies of Roman cities

have often omitted reference to sanitary matters altogether.[78] The debate about sanitation in the Roman city was opened up in strikingly new ways in the early 1980s when attention was called to several aspects of Roman life that had not seriously entered the pages of Roman history before: inadequacies in various types of Roman housing, deficiencies in the disposal of human and animal wastes, and shortcomings in the legal code.[79] Clearly all of these sad realities taken together trapped hundreds of thousands of impoverished Romans in urban squalor and easily contributed to an extraordinarily high risk of several serious problems: food and water contamination by fecal matter; a general lack of washing facilities; near proof that excrement and urine were not properly cleaned away from the streets; and woefully insufficient fly control. They also explained the high mortality rate in ancient Rome in no uncertain terms.

The conditions in Roman slums that we can glean from literary sources,[80] combined with scant archaeological evidence,[81] suggest an enormous gulf separating advantaged from disadvantaged, which was particularly evident in housing. *Ruina* were decrepit structures containing numerous defects, such as cracks in the outer walls and the lack of piped water, wash basins, and toilets, as well as damp walls, leaky roofs, and inadequate space. These structures pressed up against one another in the Subura of Rome, one of several areas in the city with extremely poor housing opportunities.[82] They caused terrible suffering for their inhabitants, in part by facilitating the spread of diseases within their walls. We can only say that those who made it to adulthood must have possessed hearty immune systems.

Although most scholars have barely taken any note of latrines and sewers in studies regarding population figures and life expectancy in Rome at various periods, evidence concerning quantities of sewage in Rome, how latrines and sewers related to the disposal of sewage, and sewage as a transmitter of diseases can open our horizons about these topics and about sanitation. The population of Rome in the early imperial period (the end of the first century B.C. and beginning of the first century A.D.) was somewhere between eight hundred thousand and one million inhabitants.[83] As a conservative estimate, that number of people could have produced approximately forty to fifty thousand kilograms of body waste per day, according to Scobie's figures.[84] What happened to that waste after it was produced? We return to this question in chapter 4, section 3.

The *Regionary Catalogs* indicate that there were 144 *foricae* (public toilets) in Rome by the fourth century A.D. Unfortunately, the figure is not very helpful in itself for determining how or if these facilities disposed of so much human waste. We are not told how many seats each *forica* contained, how many people in the general population actually used them, or how many of these public toi-

lets were connected to the main sewer system, as those connected presumably could more rapidly remove the waste. In 1986 Scobie only identified two public toilets in Rome (the one of Hadrianic date in the Forum of Julius Caesar, and one of two, the large oval latrine, in the sacred area of Largo Argentina), whereas today I have verified at least twenty-one other public or private toilets in Rome from various excavations in and around the city.[85] In most of these cases, the *foricae* and private house or shop toilets were not connected to the sewer system of Rome, which suggests that massive amounts of human waste had to be removed from the city in other ways, a topic to which we return when we discuss behaviors in chapter 4.

In addition to the stench from dung heaps in the less fashionable streets of Rome, flies would have been almost unbearable in such areas of the city, and we now know that flies transmit many diseases to humans.[86] Romans apparently tried to develop fly repellents (we hear of a mixture of coriander seed and olive oil that they could spread on house walls for this purpose[87]), but lack of screens on windows and doors, lack of refrigeration for meats and milk products, improper disposal of blood and animal by-products from butcher shops that would have used street drains, and the close proximity of many poor habitations to nearby filthy streets, especially in areas like the Subura, quickly overwhelmed any effectiveness of such treatments, if the poor could even get their hands on them in the first place.

The quantity of water reaching Rome from the aqueducts and its quality and purity for use in public baths and latrines was not as conducive to cleanliness as we might imagine. Much new research on concepts of Roman water management, the place of ecology and the environment in Roman thinking, and advances in ancient hydraulic engineering[88] has direct bearing on questions about sanitation. As much as possible, the results of these new studies should be brought into the discussion.

The ancient waterworks of Rome required tremendous structures both above and below ground. Of these, the Cloaca Maxima was certainly the largest. No Roman by the time of Augustus could have been unaware of it, even if he simply took the sewer for granted. In Rome, and other Roman towns of Roman Italy, such as Pompeii and Herculaneum, very little evidence suggests that the discharge of wastes from either atrium-style dwellings or from tenements went directly into the sewers beneath the streets. A preference for internal cesspit toilets, with no sewer connections, is definitely prevalent in Roman cities. According to the *Digest*, such connections were legal,[89] so we must wonder why so few property owners connected their dwellings to public *cloacae*?

Storm water poured into the sewers more frequently than human waste,

and the Romans seemed to understand that "poisonous effluvia"[90] could also emit from them. Roman drains lacked traps to prevent backflows into dwellings in the event of flooding and to block gases such as hydrogen sulphide (H_2S) and methane (CH_4) from escaping, so in addition to the nuisance of the odor from sewers, explosions were probably not infrequent. To a superstitious underclass, such explosions must have been frightening, and such disturbances in the streets would also have heightened general public awareness about the presence of the sewers in Rome on a regular basis.

In chapter 1 I already mentioned two dramatic "sewer" stories—one about Crates of Mallos (Suetonius, *De gramm. et rhet*. 2) and another about the murder of the Emperor Elagabalus (*SHA Heliog*. 17.1–2)—that have made their way into historical accounts about Rome. Such tales suggest that the Romans occasionally did receive vivid reminders about the role of their sewers in their lives. Suetonius also situates some of Nero's most abhorrent behavior at the openings to the sewers. After snatching a cap or wig, making rounds at the local bars, and prowling the streets, Nero would make it a game "to attack men on their way home from dinner, stab them if they offered resistance, and then drop their bodies down into the sewers."[91] The physical presence of the shrine to Venus Cloacina, Venus of the Sewer (fig. 89), along the Via Sacra in the Roman Forum would have been another visible reminder of the city's mysterious underbelly and the protection it received from the gods.

In the famous *Paris Guide* of 1867—the year tours of the Paris sewers began—Alfred Mayer, an architect for the city of Paris, evoked the 33 B.C. voyage of Marcus Agrippa through the Cloaca Maxima: "Almost two thousand years had to pass before such a trip could be taken in Paris."[92] Even ironic observers apparently couched their comments in terms of the Roman analogy. In early nineteenth-century accounts of life in Paris the "tidiness and order of the new sewer system" that impressed visitors, even ladies in their finery, contrasted strikingly with the untamed, unclean world of the sewer as people used to think of it, and correspondingly the city streets above it.[93]

The sewers of Paris, more than those in other European and American cities, seemed to live up to Pliny's somewhat exaggerated claims about "tunnels large enough to allow the passage of a wagon fully loaded with hay,"[94] since only one part of the Cloaca Maxima, the channel that ran from the Roman forum into the Tiber just south of the Pons Fabricius and the Tiber Island, has sufficient height for such a passage. The expansive Paris sewers were seen as mysterious underground rivers, waterways where only the water was unclean, and all else—walls, flooring, roofing, boats, the clothing of the workmen, side paths—were the perfection of neatness. By extension, the sewers themselves

became a proof of a cleaner and safer city above.[95] While it is tempting to follow this line of thinking back to the sewers of Rome and other Roman cities, such an approach is not productive.

We should rather understand the Great Sewer in Rome and the changes manifested in it over time as a technological solution to urban waste-water management. The sewer itself was not the answer to any crisis in urban sanitation, which did not seem to be recognized. The additions and improvements to the Cloaca Maxima indeed resulted in a more livable Rome. The removal of excess storm water, stagnant pools, and much other refuse from city streets at regular intervals must have pleased many inhabitants because of reduced stench, fewer mosquitoes, and improved urban vistas. Perhaps city planners under imperial orders, especially in Augustan Rome, cleverly used the sewer and improvements to it as political propaganda about cleanliness and urban orderliness. Pliny's pride in the system may be taken as possible evidence for such a political propaganda.

The fact remains, however, that the Cloaca and all its branches were not effective means for obtaining a healthier city, and health and hygiene, at least as we understand them today, were not the primary impetus behind the construction of the sewer or improvements to it. According to the earliest modern accounts, the Cloaca Maxima, a natural water course, was later canalized and ultimately arched over sometime after 200 B.C.[96] It underwent various repairs[97] over the centuries, and in the age of Augustus, received a major expansion. My purpose is not to discredit the achievements of Roman infrastructure. It would be easy to attack the sewage system for what is lacking according to modern principles of urban sanitation. Rather, I have tried to appreciate it for what it was to the Romans and how they used it. From the evidence, it seems clear that Rome's glorious *cloacae* were constructed primarily as culverts (for ground-water runoff), or what we usually call storm drains.

4. Water Management in Roman Cities: Sewers, Drains, Channels, and Aqueducts

Rome has the best-preserved water-supply and distribution systems of the Roman world, and they are well documented in the ancient sources.[98] While we recognize that sewers, like many other structures, need to be viewed in the full urban context in which they were initially built, unfortunately, this is not really possible for the city of Rome, since the modern city has buried much of the archaeological evidence that would show the sewers in their original built environment and establish their connections to ancient buildings. We can say

that Roman sewer builders put huge amounts of energy and resources into the construction of sewers, and we can now hypothesize that this was because the manipulation of water held great importance for developing urban landscapes.

In the countryside, water structures also played an important role for sustaining agricultural lands. In addition, the Romans had special regard for water from rivers, streams, springs, wells, and in wetlands. They cleverly manipulated water for farming, thereby ensuring an adequate food supply, first for rural areas and eventually for the growing number of denizens in cities and towns.[99]

To identify Roman attitudes toward water we can look at the development of water technology, especially in urban settings, within the overall history of the "conquest of water." Water is "one of the subdivisions of the religion of progress . . . a creed with its priests (doctors, architects, engineers), its temples and altars (aqueducts, baths . . .) and its congregations."[100] The city of Rome actually changed physically over time in part because of its beneficent natural environment, including the close proximity of an ample water supply to the main areas of habitation.

Detailed evidence (mostly from contemporary religious documents) makes it clear that after a long period of decline in the medieval period, water hugely influenced Rome's development in the Renaissance and baroque periods, with the restoration and reuse of the ancient aqueducts both for drinking water and for the construction of major decorative fountain projects.[101] Between 1560–1630, for example, at least eighty public fountains (including Piazza del Popolo, Piazza della Rotonda, Piazza Colonna, Piazza Navona, Piazza Giudea, and Piazza Mattei) and hundreds of private ones were added, and improved underground conduits removed stagnant waters from the streets.[102]

While the water systems of London and Paris of the eighteenth and nineteenth centuries have been effectively studied and clearly demonstrate that changing ideas about urban health and sanitation and developments in urban industries were often directly tied to water use,[103] application of the methodologies developed for these cities in later periods to the ancient Roman city is a dangerous business.[104] The provision of an abundant water source for the Roman city, in other words, was not necessarily inspired by concerns for public health and hygiene.

If we take into account the following points when we consider Roman water use, especially as it related to sewers and toilets, a clearer definition of an approach to aqueduct studies results: 1) Various schools of thought function within aqueduct studies. 2) Aqueducts should be studied as elements of larger water systems. 3) The relationship between public and private, which I discuss more fully in chapter 4, section 4, was as complicated for the Roman

water supply as it was for any other aspect of Roman society. 4) A serious tension exists between luxury and utility, which are not necessarily mutually exclusive, even in regard to Roman water systems. 5) Finally, we must look at aqueducts and water-supply systems not just as the creations of engineers, but as components of an entire society that built them.[105] The remains of the water-supply systems in Rome give us an indication of how water was put to use. While water use in early Rome before the construction of the aqueducts seems to be mainly utilitarian, when we come to the period of the aqueducts, we find a dynamic tension between water as a "utility" and water as a "luxury." A chronological overview of the aqueducts of Rome, at least up to the time of the emperor Augustus, and the history of their use[106] serves to highlight the relationship between water and *luxuria*.

In ancient Rome clean drinking water, a necessity for the health of rural and urban populations, was masterfully provided by the system of aqueducts started in the fourth century B.C. (fig. 90). The Aqua Appia,[107] the first aqueduct, brought water into Rome in 312 B.C. along the Via Praenestina, in part for the population near the Circus Maximus. The next line to be introduced into the city, probably between 272 and 270 B.C., was the Anio Vetus, which brought its water supply to the Esquiline Hill. Apparently built from the spoils of the Pyrrhic War, the Anio Vetus was much more ambitious in length. Rome had to wait more than one hundred years (144 to 140 B.C.) before the praetor, Q. Marcius Rex, brought in the Aqua Marcia. This aqueduct brought water to the Quirinal, where it began its delivery inside the Porta Viminalis, and from it a branch line serviced the Capitoline. The Aqua Tepula, one of the major aqueduct lines of Rome, was introduced in 126 B.C. Since it too ended inside the Porta Viminalis, it has been suggested that the Tepula was planned as a supplement to the Marcia, thereby increasing the water supply on the Quirinal. These early aqueducts (Aqua Appia, Anio Vetus, Marcia, and Tepula)[108] brought water to fountains in Rome for drinking, and their overflow would have helped to clean the streets and flush the sewers. Also, perhaps, this water was used for some agricultural irrigation within the city, though proof of farming within the city walls of Rome in the second and first centuries B.C. has been largely obliterated by continuous habitation.[109] On the surface, these aqueducts seem perfect support for the "utilitarian camp." They give us almost four hundred years of water use.

Something new was about to arrive on the Roman urban landscape, however. After the construction of the Aqua Tepula in Rome, another gap of more than one hundred years occurs before Marcus Vipsanius Agrippa, aedile in 33 B.C., built the Aqua Iulia, to which connections were made from the Aqua

Tepula.[110] With his vast wealth, which he spent freely in the service of the Roman people and the empire, Agrippa also constructed the Aqua Virgo in 19 B.C.[111] Similar to the Iulia, Tepula, and Appia, the Aqua Virgo was quite a short line, between ten and fifty Roman miles long. Waters from the Virgo serviced Agrippa's imperial baths, the first of such baths in the city of Rome, which were constructed just south of the current location of the Pantheon.[112] Enormous quantities of water were necessary for the baths, for the vast landscaped gardens adjoining them, for ornamental fountains, for a swimming channel that led to the Tiber, and for outdoor reflecting pools. With the construction of this particular aqueduct, water, for the first time in such a "public" display in Rome, became a metaphor for lavish expenditures purely for pleasure and the creation of an illusion of widespread luxury.

The Aqua Alsietina,[113] the aqueduct completed by Augustus in circa 2 B.C., seems to have been an aberration in almost every way when compared with all the others. It came into Rome from the west and apparently was intended for one specialized function, namely to provide a water supply for the *naumachia* (mock sea fight) staged by Augustus near the Transtiberim—another "luxury" usage of water. We should note that it was precisely around this time that Augustus brought the first aqueduct to the city of Pompeii. Augustan ideology encouraged cultural activity and proclaimed a renewal of virtue and morality under the banner of *pietas* (piety). This new age of peace and personal security under Augustus gave Pompeii's townscape new temples (with special emphasis on the cult of the emperor), new honorific monuments in the forum, seating by rank in the theaters, a new palaestra for the young men of the town, and improved amenities (baths and water supply).[114] In this Augustan age water was finding its way more and more into private dwellings by way of the urban lead pipe system, in Rome, in Pompeii, and in the cities of Roman North Africa.[115] It served, of course, both utilitarian and decorative purposes—for drinking, cooking, washing, flushing toilets, and for private fountain arrangements within colorfully planted gardens. When water was celebrated in lavish public displays in the Roman city, bubbling openly in *nymphaea* (large, architectural water displays), fountains, and luxurious pools in public parks and abundantly available in enormous bath complexes in which latrines often functioned with continuous flush into the sewers, then it took care of utilitarian needs, but it also symbolized the largesse of the empire, and the political power, status, and wealth wished for by many and possessed by few.

Water, even though it was invisible as it flowed beneath the streets of Roman cities, gave form to those cities at ground level, as we clearly see in the case of ancient Rome, through the new buildings and public spaces that used it.[116]

Closely tied to the topography of the Tiber River, springs, wells, aqueducts, conduits, fountains, and the Cloaca Maxima itself are the armatures along which the growing neighborhoods of Rome were established. The sound of water, whether sewage-ridden and flowing deep beneath the streets, or spring-fed, mountain fresh, and bubbling into aquatic displays, delineates and affirms the life of the city to this day. The Romans, and the Greeks before them,[117] were brilliantly attuned to local lithology, land gradients, and water catchments. They understood very well that appropriate conditions were crucial in order to obtain suitable water resources necessary for settling, and ultimately maintaining, increasingly larger nucleated populations. The successful tenacity of Roman civilization owed no small amount to water supply and distribution.

Water seems to have been rarely, if ever, in short supply, especially in Rome and elsewhere on mainland Italy. It was essential for various industries, and certainly contributed mightily to the Roman economy. The Romans were quick to appreciate the ability of water to do work, and the first application of water-power was to drive millstones to grind grain.[118] We now have ample evidence to indicate that water mills of various kinds—horizontal mills as well as undershot and overshot vertical mills—were in use as early as the Augustan period and perhaps before.[119]

One of the principle factors in Rome prompting the construction of some of the aqueducts was not the need for waterpower in food production, but the need to increase the freshwater supply for the elaborate bath buildings of the city.[120] A similar situation existed in many cities in the provinces, where aqueducts seem to have been constructed to service urban bathhouses.[121] At Pompeii the aqueduct built under Augustus finally brought an adequate supply of water to service the baths, providing a system that went well beyond the chain-bucket and well-water systems of the earlier period.[122] Water for entertainment, baths, and mock battles in the amphitheaters was lavishly available especially from the first century B.C. onward in Rome and in other cities in Roman Italy.

The hydraulic masterpieces of these cities were the consequences of many levels of choice made by top-ranking administrators. With the application of the theory of formation processes, it is possible to deconstruct some of these choices from the monuments themselves. While the creation of infrastructure for water definitely required impressive technical prowess and a well-organized bureaucracy, these were not what the Romans were most eager to show off for all of their efforts, since they regarded both with some suspicion.[123] Rather, the complex infrastructure for managing water visibly staged the pure and simple control of water in every Roman city or settlement. Water was manipulated

ingeniously with the express purpose of "owning" the natural environment: making it more productive, and making both urban and rural land more valuable. I would stress this final point. Water management was crucial within the urban environment for making property more valuable, perhaps even more so in the city than in the fields and fertile plains that produced the food for urban centers.

5. Waste Disposal and Sewage in Pompeii, Herculaneum, and Ostia

Ample evidence exists to show that Italian cities were expanding between the late third and the late first century B.C., in part, at least, through migration from the countryside.[124] Debate continues on the causes, chronology, and extent of the changes in this period,[125] but such rapidly increasing urban populations would have introduced enormous problems, including new levels of human misery, for city administrations.[126] We know, however, that elite attitudes toward the masses and their living conditions were, at best, dismissive and, at worst, callous.

Where we might hope to find standard methods of general urban waste disposal from Roman city to city, this is not at all what the evidence shows. Provisions for the removal of urine, feces, wastewater, rainwater, and overflow from fountains were markedly different in the various cities of Roman Italy.[127] Local geology—including the quality of local soils and the nature of local rock formations—and geography—including the gradients and disposition of land upon which it was possible to build—were the factors that dictated these differences, as research in the last ten years or so makes clear.[128] The Romans used at least three systems for disposing of various kinds of waste: cesspits, sewers, and runoff that flowed directly onto the streets. Here we address only large-scale urban waste removal involving sewer systems.

In less populated, unpaved centers, such as villages, rainwater naturally seeps away, especially for areas built on the slopes of hillsides. A smaller population translates into a smaller buildup of waste and sewage. In larger cities that cover a wider variety of terrain encompassing hills and valleys, low-lying areas need protection from flooding, heavily paved areas need proper drainage, and accumulations of waste are too great to ignore for very long. While the aqueducts in Rome provided more readily available fresh water, they also deposited more wastewater in the city's streets. As we have seen, the Cloaca Maxima and its branches were essential for dealing with the removal of wastewater (and some portion of other debris). How did other cities deal with this problem?

The city of Pompeii, with an estimated population of between five thousand and ten thousand inhabitants, is built on a plateau formed by an old lava flow with a considerable slope at its south end toward the sea and the Sarno River. This gradually sloping terrain (a difference of thirty meters between its highest and lowest points has been calculated)[129] certainly would have made it easy to dispose of most rain and wastewater without a complex sewer system. The city had something of a sewer system nevertheless,[130] built to deal with specific drainage problems in various points in the urban plan.

The main branches were connected to buildings where large amounts of water had to be disposed of, such as the Central, Stabian, and Forum Baths and the large palaestra near the amphitheater (fig. 91). Though far less extensive than what we find under the streets of Rome (and also not fully explored), Pompeii's sewer system demonstrates remarkable sophistication in water management. In order to deal with the small brooklets that could form along several east-west streets, planners provided not only high sidewalks and stepping stones, but also masonry barriers[131] at the entrances to some side streets in order to direct rainwater where they wanted it to flow. One smaller branch of the sewer system was designed specifically to drain the forum area,[132] and its drain hole can still be seen along the so-called Via delle Scuole. When the sewer near the Stabian Baths was excavated, it was almost two meters high.[133] Now it is inaccessible and virtually filled with debris.

Herculaneum, with an estimated population of approximately half that of Pompeii, somewhat resembles the layout of Pompeii since it, too, was built on a slope at the base of Mount Vesuvius. The *cardines* (north-south streets) of the city are constructed at a considerably steeper grade, and they would have afforded excellent drainage of water runoff toward the sea. Stepping-stones were not necessary since standing pools of water were not a problem. While niche toilets were the preferred toilet type in private houses at Herculaneum because of the compact nature of the volcanic soil (as opposed to Pompeii, where cesspits were preferred in private houses),[134] the situation for waste removal evolved somewhat at Herculaneum with the construction of the sewers under Cardo III and Cardo V (fig. 92).[135] The rainwater from the forum area, the overflow from the two fountains on the Decumanus Maximus, and the waters from the Central Baths of Herculaneum were collected into two gutters that discharged directly into the sewer on Cardo III. We can now identify many small, private connections also to this sewer.[136]

The sewer on Cardo V carried off the wastewater from the two large swimming pools of the palaestra and the considerable water runoff from this steeply

inclined street. A smaller branch of this sewer runs parallel to the street and was connected to all of the toilets situated in shops along this street.[137] Here we have definite proof of a sewer not only used for wastewater, but also for the disposal of excreta. Possibly, then, a changing ideology was at work in sewer construction from about the time of Augustus. The smaller branch of the Cardo V sewer, in fact, does not work very effectively for manipulating rainwater but seems to have been needed for the overflow of a fountain at the corner of Cardo V and the Decumanus Maximus.[138]

In any case, the geological and geographical conditions at Herculaneum were quite favorable for urban waste disposal. As time went on, sewers gradually received more and more types of urban waste, including greater quantities of excreta from toilets built along their lines. Perhaps this change in what was dumped into sewers encouraged an evolving rationale for their use in the urban infrastructure. Herculaneum, at least, allows for such an argument.

The geology and geography of Ostia were poor for sustaining adequate waste removal.[139] The town probably had a larger population than Pompeii by several thousand, especially when we take into account the inhabitants of the many apartment buildings. The town was built on slightly higher ground than the surrounding plain, but this level mound did not have any significant slope in any direction and was quite flat on the top. The nearby Tiber was prone to flooding, and we know that the high level of the water table in Ostia (.61 m. to .91 m.—circa two to three feet below ground surface) made the construction of cesspit toilets impossible.[140] This situation forced the inhabitants of Ostia to construct a substantial sewer system (fig. 93), which seems to have been designed from the start to receive excreta discharged from many houses and public buildings. Given the very slight difference in elevation from the highest to the lowest points in the town (two and a half meters), great care was also taken to direct as much water as possible—from fountain overflow and baths—directly into sewer openings. Only rainwater ran on the flat streets until it also found entry into the sewers.

The current archaeological evidence, at least the most substantial evidence we have from the towns discussed here, suggests that Romans in these Italian towns and cities of the first centuries B.C. and A.D. preferred internal cesspit arrangements to toilets with connections to main sewer lines. The situation must be studied on a town-by-town basis, however, as this survey of three small cities shows.

6. Addressing Some Technical Questions about the Cloaca Maxima and Other Urban Sewers

Roman hydraulic engineers and planners developed complex infrastructures in cities and towns of extensive sewer networks and public latrines[141] that channeled away vast quantities of water, which in turn took away much sewage. Sewer commissioners and legislation related to these sewer systems were also put in place. The questions to be asked about these systems are numerous. First of all, were the Romans aware on any level that the composition of sewage posed dangers to public health?[142] The Romans placed some value on human "waste" in agriculture, but they did not know that exposure to and improper disposal of sewage in general, whether it be excrement, urine, or other unsavory refuse, was a serious public health hazard. Debris on urban streets was certainly considered a nuisance, though we hear no outcry about it in the literary sources, except by Juvenal.[143] His complaint is more about unsafe traffic. Romans in general seem to have believed that water was an unending resource, renewable in perpetuity, and they also believed it would forever wash away all of the unpleasant filth on the ground, first into the sewers and then into the Tiber, where it would disappear and be a bother no longer.

Certainly the Romans did not know, at least in any systematic way as we know today, about such technical matters as chemical precipitations in sewer waters, the concept of aeration for sewage-laden waters, the effects of suspended matter on water, the benefits of oxygen content in sewer water (reducing stench, for example), rates of exhaustion of dissolved oxygen, water self-purification methods, rates of sedimentation in sewage channels, or the effects of wind and temperature on open sewers. Inadvertently, though, mainly through trial and error, they did seem to follow some measures that improved the efficiency of their sewers. By applying certain of these modern measures to the designs of Roman sewers, I was able to understand better the effectiveness of their operations.

Sewage disposal was mainly accomplished by water dilution, which began inside the Roman sewer and then continued in the rivers and streams into which the sewage flowed. We are left wondering if there were Roman theories about, or hands-on practices behind, this method of disposal. I had hoped that the physical features inside the sewers might help me confirm water dilution as a conscious Roman practice, but the archaeological remains do not give us enough evidence. I turn to certain engineering principles found in modern sewer design to help us clarify this matter.

The structures of the Roman sewers I have explored so far suggest that an-

cient sewer commissioners did not have any clear ideas about the chemical precipitation of sewage in water. That is, I have not found any holding pools inside the sewers that would allow this reaction before the flow reached the Tiber. Modern sewer designs take good advantage of the concept of aeration of sewage-laden water, which encourages good flow. Engineers now know that the oxidation of organic sewage material is essential, so they provide good ventilation systems in sewers. On the one hand, the infrequency of sewer openings, as we find them in Pompeii, Herculaneum, and Ostia, strongly suggests that Roman engineers did not grasp the benefits of sufficient oxygen (or air) for achieving smoother flow patterns. On the other hand, that openings to the sewers (fig. 93, for Ostia, for example), were constructed at all for access and cleaning—and at regular intervals in the system, even if widely spaced—did help to oxidize the contents in the sewers and therefore did move those contents through the sewer channels rather efficiently.

Roman designers did not take measures to combat the nuisances in the sewers caused by aquatic growths, sludge digestion, consolidations, scum, or sedimentation. Nor did they utilize filters, floats, settling basins, strains, sediment tanks, contact beds, or any type of disinfection in the sewers or in the waters into which the sewers emptied. I have reviewed other principles of modern sewer design against the archaeological remains of Roman sewers and found that virtually none of them have been applied. The Romans did not grasp the negative influence of suspended matter on water purity and flow, or if they did, they made no adjustments in their sewers' channels to compensate for it as we do today. No evidence reveals that they detected the relative effects of coarse and fine suspended matter on the oxygen content of water (quantities of air bubbles can reveal oxygen content), which today is vitally important in the treatment and reuse of sewage effluent. They did not appreciate the rate of exhaustion of dissolved oxygen in water (also evident from air bubbles in the spill), another contributor to smoother flow in sewer channels. Salinity factors were also unlikely taken into consideration in Roman sewers (encrustations of salt might have been visible along sewer channels), which would have long-term effects on the sewer channels themselves. The Romans apparently did not employ any methods of water self-purification once the sewage was "dumped" into whatever nearby river or water system was available. While they may have been aware of the effects of wind and temperature on open sewers (both affect flow and levels of stench), they leave us no record to prove it.

One might argue that I have no right to expect that the Romans would be able to apply such sophisticated theoretical knowledge underpinning modern sewer construction to their sewers, and therefore why ask about it? I would

counter, however, that these principles of sewer construction only came about by a very slow process of trial and error, so I hoped to find some evidence that the Romans might have stumbled upon some of them. In my research to date, however, this has not been the case.

Since we draw a blank on so many points of engineering design based on today's principles, we turn to the ancient literary record to tell us something about the workmen who maintained and cleaned the sewer systems. When Marcus Agrippa was aedile under Augustus, he apparently employed a team of about 240 specially trained enslaved workmen, who were later inherited by the state in accordance with Agrippa's will[144] for various hydrological projects related to the sewer. From the time of Trajan or possibly earlier, the *cura alvei et riparum Tiberis et cloacarum urbis* ("the responsibility for the river and banks of the Tiber and of the sewers of the city") formed part of the *cursus honorum* ("the course of offices") in the empire, though possibly ranking beneath the *cura aquarum* ("the responsibility for the water supply").[145]

Evidence for administration of the sewers and for any health regulations in the city concerned with it is very modest. From the period of the republic, we have a brief notice possibly explaining why changes in the sewer construction under Agrippa may have been both necessary and essential. Cicero says that the *praetor urbanus* (a city judicial magistrate) was kept busy dealing with controversies about drains, sewers, and lesser disputes concerning water.[146] Pliny the Elder[147] tells us about an important case involving a conflict between a private citizen's rights and potential damage to the sewer. Apparently Aemilius Scaurus wanted to drag columns across the Forum Romanum for a new residence he was building on the Palatine. The *redemptor cloacarum* (contractor for the sewers) protested on the grounds that such an action would surely damage the sewer under the forum, presumably by threatening to collapse the channel under the great weight. While we can only guess about other similar disputes, the story suggests that conflicts between private needs and the public administration of sewers and waterworks were not infrequent. Since *redemptores* were temporary positions, we can further hypothesize that strict oversight must have been less than perfect. Private bags of gold could have turned many an official blind eye.

While the literary record for top administrators is slim, it is even more meager concerning the status and working conditions of the men who actually carried out the construction and maintenance of sewers and drains. We do have references about imagined humiliations suffered by the Romans in the regal period during the building of the Great Sewer, notably in Livy, Pliny the

Elder, and Varro.[148] In addition, letters between Pliny the Younger and the emperor Trajan regarding problems with the river running through the city of Amastris (in modern Turkey on the Black Sea) that was under Pliny's administration are informative. The river had apparently become a serious health hazard, essentially serving as an open sewer drastically clogged with refuse. Trajan authorized Pliny to cover it up and thereby make it a more manageable enclosed sewer.[149] In a second letter, the emperor advises Pliny that the work of maintaining the sewer on a more regular basis might be effected by workers "not far removed from punishment" (that is, convicted criminals) and by communal slaves.[150] Based partly on the Price Edict of Diocletian, we can speculate that the salary paid to a *cloacarius* (trained sewer-worker) could not have provided for more than a meager daily subsistence, perhaps twenty-five denarii per day.[151] Such men were subjected to nightmarish pathogens in the wastewaters of the sewers, such as leptospirosis, sometimes causing a type of jaundice that is potentially fatal.[152]

While the cleanliness of the city's streets was generally the responsibility of the aediles, there does not appear to have been any official street-cleaning service in Rome. Property owners with adjoining street fronts were responsible for keeping them clean.[153] While rain would have washed the streets during the winter months, in the summer dry months, overflow from public basins would have cleared away only a small portion of the filth.

Execution of controls for proper disposal of waste must have been very difficult. A brief digression on the Esquiline demonstrates the point. Excavations in the nineteenth century in the area of the Esquiline graveyard revealed approximately seventy-five pits (*puticuli*) "filled with a nauseating mixture of the corpses of the poor, animal carcasses, sewage, and other garbage."[154] In addition, though their lettering is not yet securely dated, stone markers (*cippi*) were found nearby that urge against dumping sewage and corpses within the delineated area.[155] Few Romans were paying any heed to the warnings, however, since the Esquiline pits show that the violations were carried out over a long period of time. While the Roman administration was clearly attempting some kind of regulation concerning disposal in this area, the Esquiline pits show its ineffectiveness. The Lex Lucerina, dating to a period just after the foundation of the Latin colony of Luceria in 314 B.C., is relevant in this connection, however.[156] The lost stone, originally interpreted and studied by Mommsen, appears not to have been a document of sacred law relating to a sacred grove, but rather a civil law relating to regulations for a cemetery. The stone inscription of the law was posted in a graveyard probably for two reasons: to mark off a

public area in the middle of a cemetery—perhaps to provide an undertaker's headquarters—and to prevent further use of the site for burial.[157] We must wonder how attentive Romans were to this early ordinance as well.

Large-scale sewage disposal eventually becomes connected to the Cloaca Maxima, but the process is slow and apparently inconsistent. If sanitary concerns were truly on the minds of the emperors in post-Augustan Rome, we might expect to find a new sewer line running from every surviving private or public building into the newly improved *cloaca* as a result of imperial orders. The archaeological remains do not at all support such a vision. More interesting, and perhaps more telling for general hygienic conditions in Rome, is the fact that the legal texts also do not support a resurgence of connections to the main sewer after Augustus. Ulpian's *Digest*, for example, distinguishes between public sewers maintained by the state and those on private property.[158] It was the responsibility of individual property owners to clean their sewers, and they were afforded the right to connect a private sewer to a public one without hindrance after receiving permission from the *curatores viarum publicarum* ("those responsible for public streets").[159] We can surmise that no legal obligation was involved, that connections from a private dwelling to a public street sewer were completely optional, and that the owner was liable for all the expenses resulting from a decision to connect.

Perhaps the situation in other Roman towns, where the archaeological evidence is better preserved, can provide clearer indications about sewers, waste removal, and environmental issues. Such matters have only very recently been receiving serious consideration from archaeologists and hydraulic engineers alike.[160] We now know, as I have said, that the private toilets in the houses of Pompeii and Herculaneum and in the *insulae* of Ostia were not, as a rule, connected to the city's public sewers. The same conclusion has been drawn for the town of Cosa, settled in 273 B.C.[161] While Cosa had a public underground sewer system, domestic latrines, generally of the cesspit variety, did not empty into it and often sloped toward gardens at the backs of the houses.[162]

The only kind of sewer known to the Romans was the gravity sewer, which was especially susceptible to buildup of slime and sludge. The Romans did not know how to measure water velocities,[163] and therefore could not design drains with the minimum self-cleaning velocities necessary to keep the sewers free of this problem. This means, of course, that large deposits of slime and sludge on the floors of the sewers might have generated hydrogen sulfide (H_2S) and methane (CH_4), which, as we have seen, were gases that not only caused odors but also explosions and fires. The threat of such hazards would make it easy to think twice about opening a connection from one's house to the local sewer.

Furthermore, Roman sewers lacked traps. In my own explorations at Pompeii and Herculaneum, I found that entrance points to the sewer were always wide open. This means, of course, that vermin of all kinds, including rats and insects, could as easily climb out of the sewer and back up into a private house connected to it, just as wastewater could enter it. A rather startling anecdote in Aelian's *De natura animalium*[164] illustrates the perceived inherent danger that threatened when a house was connected to the public sewer. According to the tale, each night an octopus swam up through a house drain in the toilet, accessed a pantry, and ate the pickled fish stored there by Iberian merchants. As octopi are saltwater creatures, it is hard to believe that they could survive in a Roman sewer for very long, but the story would have raised eyebrows about sewer connections.

A more realistic and quite drastic risk involved with having a main sewer connection would have been the fluctuations in the level of the Tiber in Rome, which must have posed a constant threat of flooding to houses and their inhabitants. Especially in low-lying areas of Rome, the sewers frequently backed up into the network and up into any house attached to the main collectors.

The Romans only knew what we call "combined sewers," those intended to carry away excess water from public water fountains, many of which did run night and day. Sewage was pushed into them and carried along by the flowing water to the Tiber outfall. This combination possibly provided an effective fall from origin to exit point, which would have kept the sewer relatively clean and therefore free from noxious gases.[165] There is literary evidence, however, to suggest that the sewers were by no means self-cleaning. Aside from the evidence in Ulpian, we have seen that in one of the emperor Trajan's letters to Pliny the Younger, who was serving in Bithynia, Trajan suggests the cleaning of sewers as a fitting punishment for convicted criminals.[166] The unsavory job clearly had to be done from time to time in a variety of sewer systems. The problems related to accumulations in the sewers seem real enough.

All of these reasons together would have provided strong discouragement for domestic sewer connections. In addition, since human excrement was used as fertilizer (see chapter 4, section 3), its commercial value, however modest, must also have caused many to ignore the other possible conveniences of flush toilets. Nevertheless, consideration of Roman sewers and sewage removal (as well as of public latrines and urinals) deserves a place beside the analysis of clean water supply and distribution facilities when we consider the urban infrastructure. We must remember, however, that sewers were really a last resort to problems of waste removal in the Roman city rather than in the vanguard of solutions, as we expect them to be in our modern cities.