

# ROMAN ROADS IN GAUL: HOW LINES OF COMMUNICATION AND BASING SUPPORT OPERATIONAL REACH

A Monograph

by

Major Joel P. Gleason  
United States Army



School of Advanced Military Studies  
United States Army Command and General Staff College  
Fort Leavenworth, Kansas

2013-02

Approved for public release; distribution is unlimited.

<b>REPORT DOCUMENTATION PAGE</b>				<i>Form Approved</i> <b>OMB No. 0704-0188</b>	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Service, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.</small> <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
<b>1. REPORT DATE (DD-MM-YYYY)</b> 31-10-2013		<b>2. REPORT TYPE</b> SAMS Monograph		<b>3. DATES COVERED (From - To)</b> January 2013 - December 2013	
<b>4. TITLE AND SUBTITLE</b> Roman Roads in Gaul: How Lines of Communication and Basing Support Operational Reach				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Major Joel P. Gleason, United States Army				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> School of Advanced Military Studies (SAMS) 250 Gibbon Avenue Fort Leavenworth, KS 66027-2134				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSORING/MONITORING AGENCY REPORT NUMBER</b>	
<b>12. DISTRIBUTION AVAILABILITY STATEMENT</b> Approved for Public Release; Distribution is Unlimited					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> National militaries extend operational reach through the use of improved lines of communication and basing. Evidence of Roman roads and fortifications in Gaul reveals a history of physical infrastructure extending operational reach in order to increase the Roman Army's chance of success. Three case studies provide a framework for this study. First, Caesar's legions used Gallic folkways to fight in Gaul from 58-50 BC. Second, the Romans projected all forces for the invasion of Britain over roads in Gaul in 43 AD. Third, from 19 BC until the fall of Rome in the fifth century AD, along the Germanic frontier. All three periods of Roman operations in Gaul demonstrate the interplay of the components of operational reach. Poor roads and basing restricted Caesar's potential operational reach in Gaul. The deployment toward Britain over Roman roads in Gaul succeeded due to significant increases in infrastructure. On the static frontiers of the Roman empire, the army greatly reduced the potential momentum of its forces as a trade-off for greater endurance and protection.					
<b>15. SUBJECT TERMS</b> Operational Reach, Sustainment, Lines of Communication, Basing, Rome, Caesar, Gaul, Endurance, Momentum, Protection, Roads, Ancient History.					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b> (U)	<b>18. NUMBER OF PAGES</b> 63	<b>19a. NAME OF RESPONSIBLE PERSON</b> John Paganini, COL, US Army
<b>a. REPORT</b> (U)	<b>b. ABSTRACT</b> (U)	<b>c. THIS PAGE</b> (U)			<b>19b. TELEPHONE NUMBER (Include area code)</b> 913-758-3302

MONOGRAPH APPROVAL PAGE

Name of Candidate: MAJ Joel P. Gleason

Monograph Title: Roman Roads in Gaul: How Lines of Communication and Basing Support  
Operational Reach

Approved by:

\_\_\_\_\_, Monograph Director  
Ricardo A. Herrera, Ph.D.

\_\_\_\_\_, Seminar Leader  
John M. Paganini, COL

\_\_\_\_\_, Director, School of Advanced Military Studies  
Henry A. Arnold, COL

Accepted this 31<sup>st</sup> day of October 2013 by:

\_\_\_\_\_, Director, Graduate Degree Programs  
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

## ABSTRACT

ROMAN ROADS IN GAUL: HOW LINES OF COMMUNICATION AND BASING SUPPORT OPERATIONAL REACH, by MAJ Joel P. Gleason, 45 pages.

National militaries extend operational reach through the use of improved lines of communication and basing. Evidence of Roman roads and fortifications in Gaul reveals a history of physical infrastructure extending operational reach in order to increase the Roman Army's chance of success. This comparison of the Roman roads and basing in ancient Gaul to the modern concept of operational reach and its components (momentum, endurance, and protection) emphasizes the impact of infrastructure on military operations.

Three case studies provide a framework for this study. First, Caesar's legions used Gallic folkways to fight in Gaul from 58-50 BC, which caused challenges to momentum, endurance, and protection limiting operations. Second, the Romans projected all forces for the invasion of Britain over roads in Gaul in 43 AD. Third, from 19 BC until the fall of Rome in the fifth century AD, the Germanic frontier exchanged almost all possibility of momentum for a substantial increase in endurance and a significant increase in protection to the greater empire.

All three periods of Roman operations in Gaul demonstrate the interplay of the components of operational reach. The increase in one element, in most cases, will cause the drop of another unless technology or infrastructure increases them all. Poor roads and basing restricted Caesar's potential operational reach in Gaul. The deployment toward Britain over Roman roads in Gaul succeeded due to significant increases in infrastructure allowing greater endurance and momentum. On the static frontiers of the Roman empire, the army greatly reduced the potential momentum of its forces as a trade-off for greater endurance and protection.

## ACKNOWLEDGMENTS

Like any significant project, I was able to accomplish this monograph through teamwork and assistance and I would be remiss to claim that the citations and bibliography represented all of the credit that was due to outside sources. First, I want to thank my monograph director, Dr. Ricardo Herrera, for reading over everything from initial rambling scraps to final drafts and giving me just the right measure of quality direction, motivation, and feedback. My sense of history improved immensely under his instruction. I am also grateful to Majors Matthew Blome and Angelica Martinez who helped to shape my initial question and direction into this final product. Finally, from the SAMS faculty, I would like to thank Colonels R. Joseph Dixon and John Paganini whose leadership helped ensure that this project holds a military purpose and not just an academic one.

There are several influences outside of SAMS that also deserve mention in the development of this project. Mr. Bob Bayless and Mr. G. Mike Stephenson, both of the CGSOC faculty, added greatly to my knowledge of operational sustainment and history, respectively, leading me to this particular topic. Dr. John Hosler, of Morgan State University, was generous enough to get me started with a list of sources focused on the root of my research question. I must also give a nod to Anthony Everitt's *The Rise of Rome*, which inspired me to look at the roads.

In a personal note, I would like to thank my close friend Major Jake Atkins who helped me to stay physically tough while acting as a sounding board to much of my research. To close, I must mention my deepest gratitude to my beautiful wife, Trista, who has certainly given the most toward the completion of this monograph. In the process of this writing and many others, she has always offered patient encouragement. Her support throughout my career has made me a better leader and a better officer.

## TABLE OF CONTENTS

	Page
ILLUSTRATIONS .....	VI
INTRODUCTION .....	1
LITERATURE REVIEW .....	7
UNDERSTANDING OPERATIONAL REACH .....	13
JULIUS CAESAR OVER GALLIC ROADS .....	20
TOWARD BRITAIN OVER GALLIC ROADS .....	25
THE GERMANIC FRONTIER OVER GALLIC ROADS .....	32
CONCLUSION: THE OPERATIONAL REACH OF ROME .....	41
APPENDIX A: MUTUAL SUPPORT ON THE RHINE FRONTIER.....	48
APPENDIX B: THE COST OF THE MUSCLE & ANIMAL POWER OF ROME.....	50
BIBLIOGRAPHY .....	52

## Illustrations

	Page
DIAGRAM OF HOW OPERATIONAL REACH RELATES TO BOUNDARIES .....	20
MAP OF THE EASTERN ROMAN TERRITORY BEFORE CAESAR'S CONQUEST.....	21
MAP OF THE FOUR MAJOR TRANSPORTATION CORRIDORS IN GAUL.....	28
MAP OF THE RHINE FRONTIER, CIRCA 100 AD .....	33
DISTANCES BETWEEN MUTUALLY SUPPORTING BASES ALONG THE RHINE.....	48
THE DEPLOYMENT OF ROMAN LEGIONS STATIONED ON THE RHINE FRONTIER...	49
THE FULLY BURDENED COST OF FODDER (FBCF) .....	50

## Introduction

The imperial Roman Army was too small to conquer the enemies of Rome.<sup>1</sup> The army consisted of 28 legions for much of the imperial period, between 4800 to 6000 heavy infantry in each at its full strength. A roughly equal number of auxiliary troops and a limited fleet supported the legions making around 270,000 total soldiers and sailors, but these forces were numerically insufficient to hold back a host of potential enemies.<sup>2</sup> Instead of massive forces, the Romans developed a complex system of all-weather roads with supporting fortifications that allowed them to extend the operational reach of their small forces to the edges of the empire.<sup>3</sup> Durable, all-weather roads facilitated an increased rate of march for heavy legionary infantry forces, which increased the Roman Army's potential reach and defined the boundaries Rome could call its own.<sup>4</sup>

In today's terms, operational reach is the distance and duration possible for a military force to operate. U.S. Army doctrine further divides reach into terms of endurance, momentum, and protection.<sup>5</sup> Each of these subordinate elements is observable through studying the operations of the Roman Army. Scholars have estimated the potential endurance that Roman forces possessed by examining the tempo of their operations and the availability of the resources

---

<sup>1</sup> N.G.L. Hammond and H.H. Scullard, eds., *The Oxford Classical Dictionary*, 2nd ed. (Oxford: Oxford University Press, 1970), 591–593; Edward N. Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third* (Baltimore: The Johns Hopkins University Press, 1976), 13.

<sup>2</sup> G.L. Cheesman, *The Auxilia of the Roman Imperial Army* (Chicago: Ares Publishers, 1914), 53–56.

<sup>3</sup> Logan Thompson, “Roman roads,” *History Today* 47, no. 2 (1997): 21–22; Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 45, 61–67.

<sup>4</sup> Gaius Suetonius (Suetonius) Tranquillus, *The Twelve Caesars*, ed. T. Forester, trans. Alexander Thomson, Kindle ed., n.d., 155–156; Tacitus, *The Complete Tacitus Anthology*, Kindle ed. (Bybliotech.org, 2012), Annals 1.9.

<sup>5</sup> Department of the Army United States, *Army Doctrine Reference Publication 5-0: The Operations Process* (Washington, DC: Headquarters, Department of the Army, 2012).



required to conduct those operations. By comparing historical records with estimates of the numbers the Roman Army could have mobilized at one time within the resources and capabilities of that era, it is possible to estimate Roman operational momentum. Evidence also exists to show that the Romans used road placement for the protection of their combat power during operations with extended distance and duration.

Nations can project power and their armed forces can extend operational reach through the use of improved lines of communication and basing. Evidence of Roman roads and fortifications in Gaul reveals a history of one military's use of physical infrastructure to extend its operational reach in order to increase the Roman Army's chance of success. Since practice always precedes the development of good theory, scholars should ask the question, how does modern doctrine provide for operational reach? A comparison of the Roman roads and basing in ancient Gaul to the modern concept of operational reach and its components (momentum, endurance, and protection) emphasizes the impact of infrastructure on military operations.

Examining how the Roman Army operated within the geographic and temporal boundaries of its potential operational reach prompts a further comparison of the modern U.S. Army principles of sustainment. Today's sustainment professional speaks of the principles of economy, improvisation, survivability and simplicity. The Roman Army demonstrated all of these concepts. The stations and fortifications along the road network supporting the movement of troops in any direction at any time provide clear examples of principles that planners today call responsiveness and anticipation.<sup>6</sup>

Operational reach is often the deciding factor in establishing the extent of geographic and temporal boundaries an army can control. The possible distance and duration of prospective

---

<sup>6</sup> Department of the Army United States, *Army Doctrine Reference Publication 4-0: Sustainment* (Washington, DC: Headquarters, Department of the Army, 2012), 1-2 – 1-4. The United States Army's principles of sustainment are integration, anticipation, responsiveness, simplicity, economy, survivability, continuity, and improvisation.

action define the area of influence for an operational commander as well as the tempo at which a military organization can accomplish sequenced phases.<sup>7</sup> In terms of modern U.S. Army doctrine, operational reach, supported by lines of communication and basing, is both the measure and the purpose of sustainment in operational art.<sup>8</sup>

Understanding the manner in which infrastructure can extend a force's operational reach augments a staff officer's resources. In light of the mission within Army Strategic Planning Guidance 2013 to project power despite anti-access and area denial challenges, studying how infrastructure placement and employment increases force projection capacity is relevant for commanders and planners alike.<sup>9</sup> Records of the roads within the Roman empire provide one of history's most famous examples of infrastructure that enabled what modern commanders would call extended operational reach. The history of Roman roads serves as a tool for commanders and planners to develop a greater understanding of infrastructure in projection.

The principal roads of imperial Rome, constructed chiefly to move military forces across the empire, illustrate the effects lines of communication and basing have on extending reach. The Romans built all weather roads to increase the flexibility and speed of their legions.<sup>10</sup> They constructed the roads in a manner that allowed the easy passage of load-bearing vehicles through all manner of terrain from swamps to mountains. The routes the surveyors selected were direct,

---

<sup>7</sup> Department of the Army United States, *Army Doctrine Reference Publication 3-0: Unified Land Operations* (Washington, DC: Headquarters, Department of the Army, 2012), 1–13.

<sup>8</sup> Department of the Army United States, *Army Doctrine Publication 4-0: Sustainment* (Washington, DC: Headquarters, Department of the Army, 2012), iv. Figure 1, diagrams the US Army doctrinal concept of sustainment as nesting into operational art through operational reach; Joint Chiefs of Staff United States, *Joint Publication 4-0: Joint Logistics* (Washington, DC: Department of Defence, 2008), I–1. defines the result of sustainment as extended operational reach.

<sup>9</sup> Raymond T. Odierno and John M. McHugh, *Army Strategic Planning Guidance 2013* (Washington, DC, 2013), 1.

<sup>10</sup> Justinian, *The Digest of Justinian*, trans. Alan Watson, vol. 4 (Philadelphia: University of Pennsylvania Press, 1985), 43.7.3; Raymond Chevallier, *Roman Roads*, trans. N.H. Field (Berkeley: University of California Press, 1976), 65–66; Thompson, “Roman roads,” 21.

avoiding obstacles and locations of potential ambushes as well as population centers. Roman roads often followed straighter lines than surveyors would be capable of making again until the Renaissance, but even when curved they provided the most direct route the Romans could secure.

The most important Roman roads were not commercial. The laws of Rome defined four categories of road, the military road being the highest quality. The law defined military roads by their paved or graveled quality, their public maintenance, and their termination either at the sea or at an intersection with another military road. Other public roads, private roads, and city roads were less important in the eyes of the law. Commerce mostly went by sea and barge. For the protection of commercial traffic, the law prohibited any action that might reduce the navigability of a waterway, demonstrating the importance of waterborne commerce.<sup>11</sup> Lionel Casson, in *Travel in the Ancient World*, argues that the exorbitant cost of transporting goods over land when river and sea transportation were available is evidence against the extensive commercial use of roads in ancient times.<sup>12</sup>

The primary purpose of the roads, therefore, was military. Roman commanders used these roads to project forces inside the empire to extinguish rebellions as well as to transport troops to the frontiers for conquest and defense.<sup>13</sup> In order to extend their reach to the major rivers, mountain ranges, deserts, and oceans that the Romans considered the natural extent of the empire, the army constructed way stations and basing along the roads and at the edges of the

---

<sup>11</sup> Justinian, *The Digest of Justinian*, 4:43.7.3 & 43.7.12–15.

<sup>12</sup> Lionel Casson, *Travel in the Ancient World* (Baltimore: The Johns Hopkins University Press, 1994), 65, 129–130.

<sup>13</sup> Flavius Josephus, *The Works of Josephus: New Updated Version Complete and Unabridged in One Volume*, trans. William Whitson (Peabody, MA: Hendrickson Publishers, 1987), Jewish Wars 3.7.3. Josephus provides a clear example of Titus using roads to project forces. In this same campaign, Titus repairs the roads ahead of tactical action in order to march his troops more expediently to battle.

frontier.<sup>14</sup> The history of Roman Gaul provides ample illustrations of the use of roads and basing in the conquest of a territory, roads supporting the projection of legions outside and within the empire, as well as roads supporting the Germanic frontier.<sup>15</sup>

The first Roman road to extend beyond the Italian peninsula, the Via Amelia Scauri, crossed the Alps in 107 BC. That road, which followed the Mediterranean coast to Iberia, eventually acquired the name Via Julia Augusta. These roads and others like them allowed republican Rome to project forces north into Cisalpine Gaul against invasion as well as to maintain colonies in Transalpine Gaul and Iberia.<sup>16</sup>

Before the Roman Army ever constructed the Via Julia Augusta in the Roman style, Rome had secured the southern reaches of Gaul around Massilia as the province of Narbonensis to prevent any further invasion along the route Hannibal used during the Second Punic War (218-201 BC).<sup>17</sup> The final conquest and settling of the rest of Gaul began in 58 BC. Roman legions under Gaius Julius Caesar deployed north of Massilia (modern Marseilles) to begin a series of battles against the tribes along the Rhone and Rhine rivers that eventually led to the conquest of all of Gaul. Throughout this conquest, Caesar's army continued to improve upon the "already developed river-roads as well as folk-ways, which were mainly dirt tracks."<sup>18</sup> Key parts of the

---

<sup>14</sup> Tacitus, *The Complete Tacitus Anthology*, Annals 1.9; Tranquillus, *The Twelve Caesars*, 155–156; Casson, *Travel in the Ancient World*, 187. Casson's discussion of the *cursus publicus* (public courier) includes a concise explanation of the system of way stations along the military roads for the couriers as well as the army; also see H. Schonberger, "The Roman Frontier in Germany : An Archaeological Survey," *The Journal of Roman Studies* 59, no. 1/2 (1969): 144–197.

<sup>15</sup> Ibid., 150.

<sup>16</sup> The term Cisalpine Gaul refers to the territory that is now the modern Italian Alps.

<sup>17</sup> Adrian Keith Goldsworthy, *In The Name of Rome: The Men Who Won the Empire* (London: Orion Books, 2003), 32–49.

<sup>18</sup> Victor W. Von Hagen and Adolfo Tomeucci, *The Roads that Led to Rome* (Cleveland, OH: The World Publishing Company, 1967), 195.

narrative of Caesar's own history regarding the Gallic Wars detail the building of bridges over swamps and rivers in pursuit of the enemy.<sup>19</sup>

After conquest, the Roman Army further developed the roads within Gaul ensuring the legions had improved access to the entire province allowing Rome to suppress potential rebellion as well as impede the Germanic threat along the Rhine River. Certain early roads supported Caesar's return in 50 BC in order to crush a rebellion led by the Gallic warrior Vercingetorix. Again, in 14 AD the roads of Gaul supported a punitive invasion of Germania. The roads continued to be a priority to the empire and, by 41 AD, the road network in Gaul was supporting the movement of troops and supplies from the Mediterranean to the Bay of Biscay and the English Channel to support the pending invasion and conquest of Britain.<sup>20</sup> In addition to legions and auxiliaries, the army moved grain and other necessary supplies over the roads to support the projection of Roman forces.

By the second century AD, the Roman Army's operational reach extended to the limit of its natural boundaries and the imperial policy became defensive rather than a policy of conquest.<sup>21</sup> The Roman Army used the critical infrastructure of the road network to defend the frontier, or *limes*, by employing what U.S. doctrine today calls "economy of force." The road network allowed the Roman Army to "allocate minimum essential combat power" to the borders and maintain the defense of an empire over 4000 kilometers across (covering 33 degrees of latitude and 34 degrees of longitude of the surface of the Earth) with only 28 legions.<sup>22</sup> This period of

---

<sup>19</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*. Also see Henry O. Forbes, "The Topography of Cæsar's Last Campaign against the Bellovaci," *The Geographical Journal* 59, no. 3 (1922), 196.

<sup>20</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*, 213.

<sup>21</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 55–60.

<sup>22</sup> Department of the Army United States, *Field Manual 1-02: Operational Terms and Graphics* (Washington, DC: Headquarters, Department of the Army, 2004), 1–67. The full definition of Economy of Force is, "One of the nine principles of war: Allocate minimum

defensive policy informs the modern staff officer about how lines of communication and basing can best support extended operational reach.

Nations have used lines of communication and basing to extend the operational reach of their militaries for thousands of years. Although codified doctrine defining the elements of operational art appears to be a recent development in warfare, many of the ideas behind those principles were extant long before military theorists and doctrine writers developed precise definitions. These discernible, categorized principles became an integral part of U.S. Army doctrine partially because historical evidence demonstrated their usefulness. The extension of an army's operational reach through the use of improved lines of communication and basing is at least as old as the roads of Rome.

## Literature Review

In the one-thousand, five-hundred and thirty-seven years since the fall of the Western Roman empire in 476 AD, many authors have taken up the pen to expound upon the history of the empire. Even before that time, the Roman people themselves had a rich tradition of writing history and a government administration with codified laws and documented business transactions constituting the earliest written evidence of Rome. A scholar, literate in just one language could spend a lifetime reading and never exhaust himself of scholarly texts on the subject of Rome. Within this seemingly infinite body of literature, there are many dedicated

---

essential combat power to secondary efforts.” This should not be confused with the principle of sustainment, “Economy,” which *ADRP 4-0: Sustainment* (Washington, D.C.: Headquarters, Department of the Army, 2012) defines as, “providing sustainment resources in an efficient manner that enables the commander to employ all assets to the greatest effect possible.” For more on mapping the geographic span of the Roman Empire at its height, see Walter Scheidel, “Princeton/Stanford Working Papers in Classics: The Shape of the Roman World” (Stanford, 2013), 1–27. For more on the numbers of legions in the Roman Army at various times, see Paul Erdkamp, *A Companion to the Roman Army* (Malden, MA; Oxford: Blackwell, 2007), 188–197. At the height of conflict in the late second century, the number of legions increased to 31 for a period but 28 legions supported by the auxiliaries was the extent of the army for most of the imperial period.

works on the roads and fortifications that the Roman Army used, and many more with a section or two addressing the topic. The body of work on the topic requires the scholar to narrow himself to the best literature.

Starting with the body of Roman writings, Flavius Vegetius Renatus's, *Military Institutions of the Romans* is a classic on an idealized form of the Roman Army.<sup>23</sup> Julius Caesar wrote two volumes on his own conquests including *The Gallic War* which recorded his legions' conquest of Gaul.<sup>24</sup> Caesar wrote a the second volume, most likely to influence the political landscape as he fought a civil war throughout the Mediterranean basin. Other prominent Romans, especially, Livy, Suetonius, Plutarch, Tacitus, and Polybius wrote histories that include much about Roman life.<sup>25</sup> The works of a great number of Roman contemporary historians and the records of Roman laws maintained through works like the *Theodosian Codex* combine with archaeology and artificats, such as Trajan's Column, to provide a broad picture from certain periods of ancient Rome for historians to interpret.<sup>26</sup>

A key text on the subject of Roman roads is Raymond Chevallier's, *Roman Roads*.<sup>27</sup> His book is a veritable catalogue of details and terms regarding the construction, management and maintenance of the roads. Victor von Hagen narrated a photographic tour of key archaeological road sites in *The Roads that Led to Rome*, capturing details about Roman roads as they showed in

---

<sup>23</sup> Flavius Vegetius (Vegetius) Renatus, *Military Institutions of the Romans*, ed. Thomas R. Phillips, trans. John Clark (Harrisburg, PA: Stackpole Books, 1944). More commonly, both the author and the work are simply referred to as "Vegetius."

<sup>24</sup> Julius Caesar, *The Complete Works of Julius Caesar*, trans. W.A. McDevitte and W.S. Bohn, Kindle ed. (Amazon.com: Kindle Public Domain Books, n.d.).

<sup>25</sup> Titus (Livy) Livius, *The History of Rome: In Three Volumes*, trans. D. Spillan, Unexpurgat. (Amazon.com: Halcyon Classics, n.d.); Tranquillus, *The Twelve Caesars*; Plutarch, *Plutarch: Lives of the noble Grecians and Romans*, Kindle ed. (Amazon.com: Kindle Public Domain Books, n.d.); Tacitus, *The Complete Tacitus Anthology*; Polybius, *The Complete Histories of Polybius*, trans. W.R. Paton, Kindle ed. (Digireads.com Publishing, 2010).

<sup>26</sup> Simon Corcoran, ed., *Codex Theodosianus: Le code Théodosien V.*, trans. S. Petrequet-Crogiin, P. Jaillette, and J.M. Poinssotte, vol. 5 (Brepols Publishers, 2009).

<sup>27</sup> Chevallier, *Roman Roads*.

physical evidence prior to 1967.<sup>28</sup> Apart from these two works, the majority of the English language scholarship that specifically focuses on the subject of roads is in scholarly journals.<sup>29</sup> Most of these articles fall into three types of works focused on the roads: a limited number of broad and general works; a relatively large collection of works that focus on one or two specific roads, usually in a specified time-period; and works that develop around a feature of the road or its traffic.

Although many other sources have secondary information about Roman roads, the best concentration is in three categories: records of Roman laws; works on the boundaries and maps of the empire; and works on traffic and logistics. Roman laws provide written evidence of how Rome intended the army and the roads to function. The boundaries and maps of the empire show the configuration of the physical infrastructure. Historic assessments of the traffic on the roads and the logistics of Rome indicate how the lines of communication and basing actually extended the operational reach of the Roman Army.

Books of Roman law, containing concepts and language that are still reflected in modern legal documents through their peculiar phrasing and even their subject matter, offer specific evidence of how lawmakers intended for the roads to function. The *Theodosian Codex*, the *Digest of Justinian*, and the *Institutes of Justinian* provide a well-spring of information regarding the normative expectations the Roman emperor and the senate had about the roads. Roman laws dictated the building, maintenance, types, and uses of roads. In addition, there are clear indications of the importance of waterways and highways from laws directly prohibiting their obstruction. Equally pertinent to a discussion of roads are the laws that governed the public

---

<sup>28</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*.

<sup>29</sup> Thompson, "Roman roads"; T. Ashby and R.A.L. Fell, "The Via Flaminia," *The Journal of Roman Studies* 11 (1921): 125–190; Ernest Straker and Ivan D. Margary, "Ironworks and Communications in the Weald in Roman Times," *The Geographical Journal* 92, no. 1 (1938): 55–60.



couriers.<sup>30</sup> These laws contribute to a more complete picture of lines of communication from the seat of government to the army and the frontier.

Stephen L. Dyson's, *Creation of the Roman Frontier*, discusses the development of selected roads in periods of conquest and colonization.<sup>31</sup> Likewise, several atlases of the Roman and ancient world have been useful to this study.<sup>32</sup> Scholarly works regarding itineraries including the Peutinger Table, a twelfth century reproduction of a fourth or fifth century map of the entire Roman world from Iberia to India, provide insight into how the individual roads served as a network.<sup>33</sup>

To end the list of resources, at least in the context of maps, the Stanford Geospatial Network Model of the Roman World, a modeling website, serves as a useful ancillary tool to any scholar seeking to study any topic with a connection to Roman transportation.<sup>34</sup> The time and distance calculations possible from this site's data offer support to a multitude of arguments about operational reach. This model makes the connection between the Roman roads and ancient travelers much more tangible.

---

<sup>30</sup> A.M. Ramsay, "The Speed of the Roman Imperial Post," *The Journal of Roman Studies* 15 (1925): 60–74.

<sup>31</sup> Stephen L. Dyson, *The Creation of the Roman Frontier* (Princeton: Princeton University Press, 1985).

<sup>32</sup> Tim Cornell and John Matthews, *Atlas of the Roman World*, ed. Graham Speake et al. (New York: Facts on File, 1982); J.A. Talbert, ed., *Atlas of Classical History* (New York: Macmillan Publishing Company, 1985); Patrick O'Brien, ed., *Atlas of World History*, 2nd ed. (New York: Oxford University Press, 2002).

<sup>33</sup> O.G.S. Crawford, "A Note on the Peutinger Table and the Fifth and Ninth Iters," *The Journal of Roman Studies* 14 (1924): 137–141; José Luis Vicente González, "GIS and roman ways research in hispania," in *ESRI European User Conference 2011*, 2011, 23, <http://evento.esri.es/es/euc/agenda/ponencia/investigacion-de-la-red-viaria-romana-de-hispania-mediante-tecnologias-sig-gis-and-roman-ways-research-in-hispania/>; A.N. Sherwin-White, "The Tabula of Banasa and the Constitutio Antoniniana," *The Journal of Roman Studies* 63 (1973): 86–98.

<sup>34</sup> "ORBIS", n.d., <http://orbis.stanford.edu/#mapping> (accessed September 27, 2013); For details on the development of this model, please reference Walter Scheidel, Elijah Meeks, and Jonathan Weiland, *ORBIS: The Stanford Geospatial Network Model of the Roman World*, 2012.

There are more sources on ancient travel than the roads themselves. M. P. Charlesworth's *Trade-Routes and Commerce of the Roman Empire* considers the Roman roads from an economic perspective.<sup>35</sup> Lionel Casson's *Travel in the Ancient World* offers a comprehensive survey of all travel from commercial, to military, to leisurely.<sup>36</sup> Many other articles on various modes of transport and types of traffic combine to build a picture of what the Roman Army's logistical support probably looked like.<sup>37</sup> Jonathan Roth's study, *Logistics in the Jewish War*, largely supported by the works of ancient Jewish historian, Flavius Josephus, gives his reader an idea of what logistics probably looked like across the empire.<sup>38</sup>

Adrian Goldsworthy, in an appendix of *The Roman Army at War*, argues that historians cannot discover the actual capacity of carts, wagons, and load-bearing animals from the Roman era but many scholars, Goldsworthy included, venture to estimate the capability of these platforms.<sup>39</sup> To replicate and verify some estimates scholars rely on data from the late nineteenth century provided in works like Colonel Garnet J. Wolseley's, *Pocket Book for Field Service*.<sup>40</sup> Although often not directly addressing the roads, these works help in estimating the constitution

---

<sup>35</sup> M.P. Charlesworth, *Trade-Routes and Commerce of the Roman Empire*, 2nd ed. (Cambridge: Cambridge University Press, 1926).

<sup>36</sup> Casson, *Travel in the Ancient World*.

<sup>37</sup> Stephen Mitchell, "Requisitioned Transport in the Roman Empire : A New Inscription from Pisidia," *The Journal of Roman Studies* 66 (1976): 106–131; Peter Garnsey, Tom Gallant, and Dominic Rathbone, "Thessaly and the Grain Supply of Rome during the Second Century B. C.," *The Journal of Roman Studies* 74 (1984): 30–44; Olwen Brogan, "Trade between the Roman Empire and the Free Germans," *The Journal of Roman Studies* 26 (1936): 195–222. These articles provide examples of various studies on the types of traffic on the Roman roads.

<sup>38</sup> Jonathan Roth, *The Logistics of the Roman Army in the Jewish War* (Ann Arbor, MI: UMI Dissertation Services, 1991); Josephus, *The Works of Josephus: New Updated Version Complete and Unabridged in One Volume*.

<sup>39</sup> Adrian Keith Goldsworthy, *The Roman Army at War: 100 B.C. - A.D. 200* (Oxford: Oxford University Press, 1996) Appendix A.

<sup>40</sup> Garnet J. Wolseley, *The Soldier's Pocket-Book for Field Service*, 2nd ed. (London: Macmillan and Co., 1871); Another example is Charles Teague, *Gettysburg by the Numbers: The Essential Pocket Compendium of Crucial and Curious Data about the Battle* (Gettysburg, PA: Adams County Historical Society, 2006).

of the total Roman forces, including logistics and other necessities in order to understand what limited the Roman Army's operational reach.

Regarding the constitution of the Roman forces, the evidence available about the Roman government and legions is adequate and then becomes more scarce as scholars seek information about the navy, the auxilliary troops, Roman logistics, and the fielded forces of Rome's enemies. Edward Luttwak's, *The Grand Strategy of the Roman Empire*, focuses on the strategic employment of the Roman Army.<sup>41</sup> Two works partnered together provide a fairly comprehensive look at the legions and their support considering the available evidence. The first is Brian Campbell's, *The Roman Army: a Sourcebook*, which organizes short quotations, paragraphs, verses, and sentences from multiple primary sources according to broad topics.<sup>42</sup> Second is Paul Erdkamp's *Companion to the Roman Army*, which catalogues and details much of the available information about the Roman Army in well-researched detail.<sup>43</sup> Erdkamp's text is divided by time period as well as topic and contains a wealth of information about the organization, equipping, training and stationing of the Roman Army, especially the legions.

Sure details about the Roman auxilliary forces are regrettably less authoritative. George Cheesman has written a small volume, *The Auxilia of the Roman Imperial Army*, that is considered by many the most authoritative work on the subject.<sup>44</sup> Outside of this work, the bulk of the discussion of the auxillaries or *auxilia* is contained in chapters within the works on the Roman Army as a whole. For example, Philip Matyzak, who has published both scholarly and

---

<sup>41</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*.

<sup>42</sup> Brian Campbell, *The Roman Army, 31 BC-AD 337: A Sourcebook* (London: Routledge, 1994).

<sup>43</sup> Erdkamp, *A Companion to the Roman Army*.

<sup>44</sup> Cheesman, *The Auxilia of the Roman Imperial Army*.

popular works on ancient Rome provides a very concise discussion of the life of the auxilliary soldier in his, *Legionary*.<sup>45</sup>

In a manner similar to the auxilliary troops' coverage, the enemies of Rome are often grouped under the title "barbarians" and covered in single chapters of other works. One text that covers the topic in much greater depth is, *Rome and the Barbarians*, by Thomas Burns.<sup>46</sup> Burns' book details the relationship that Rome had with the tribes on its borders in both war and peace over 500 years. This work and several more detailed scholarly articles provide details about Rome's actual and potential enemies.

The history of how Rome, specifically the Roman Army, extended their operational reach in Gaul through the use of lines of communication and basing will only provide a baseline to determine how modern doctrine provides for operational reach. Modern U.S. doctrine publications stand as the remaining literature for defining operational reach. The foremost two sources are *Army Doctrine Reference Publication 3-0: Unified Land Operations*, and *Army Doctrine Reference Publication 4-0: Sustainment*. These sources are supported by Joint (all service) publications and other publications in providing definitions and constructs for modern concepts. The leading references will be those that define operational reach and other principles that extend the distance and duration of military operations.

## Understanding Operational Reach

Modern military thought approaches the question of the distance and duration to which a commander may employ force from two counterbalanced concepts. The first is operational reach. Increasing operational reach improves the potential employment of force available to

---

<sup>45</sup> Philip Matyszak, *Legionary: The Roman Soldier's (Unofficial) Manual* (London: Thames & Hudson LTD, 2009).

<sup>46</sup> Thomas S. Burns, *Rome and the Barbarians: 100 B.C.-A.D. 400* (Baltimore: The Johns Hopkins University Press, 2003).

commanders. U.S. Joint doctrine identifies operational reach as the primary purpose of sustainment.<sup>47</sup> The element countering operational reach is culmination. Culmination identifies the point where a military force exhausts its operational reach, “that point in time and space at which a force no longer possesses the capability to continue its current form of operations.”<sup>48</sup> The edge that bounds the full extent of operational reach against the face of culmination is a point of risk that commanders and staff officers must understand in order to properly resource the desired end state of an operation.

The edge of reach and culmination then becomes the optimal boundary for an operation because it represents the maximum potential force without exceeding capabilities. Modern U.S. Army doctrine defines both operational reach and culmination in terms of distance and duration (or time and space) which indicates that the boundaries planners can identify by understanding this edge are both geographic as well as temporal. To apply these modern concepts to an interpretation of Roman history, one must first comprehend how the Roman military commander, from emperor to military tribune, saw distance and duration.

Understanding roads the way that the Roman commander saw them requires modern scholars to forget for a moment the geographically accurate textbook map of the Roman empire. It is also important to separate the various legionary commanders from the entirety of the Roman population and to leave discussions about Roman education regarding geography to another conversation. What the Roman commander understood of geography was more likely in terms of route itineraries from the edges of the Mediterranean Sea or Rome.<sup>49</sup> These itineraries were very

---

<sup>47</sup> United States, *Joint Publication 4-0: Joint Logistics*, vii, I–1.

<sup>48</sup> United States, *Army Doctrine Reference Publication 3-0: Unified Land Operations*, 4–8.

<sup>49</sup> The words *iter* and *itineraria* can both be translated itinerary but can also mean road, route, and trip. In this instance, it is most clear to use English since the meaning of “itinerary” is not far from its Latin root. For more on the use of itineraries see Casson, *Travel in the Ancient World*, 186. To read further on the enduring use of itineraries when maps were not readily

basic lists of locations along a road that often started at Rome and continued until some natural terrain feature such as an ocean, mountain range, great desert, or major river stopped them. These were the boundaries of the Roman empire.

Archaeological sources and the rich tradition of geographic writing from ancient Roman texts clearly indicate that the Romans had maps. Evidence exists of maps describing greater portions of the Roman world. The Peutinger Table serves as proof that the Romans understood graphic representations of the earth's surface as seen from above.<sup>50</sup> Many other remaining or discovered maps detail local agricultural plots or schemes of cities.<sup>51</sup>

The evidence of maps as a tool used during land travel, on the other hand, is thin to non-existent.<sup>52</sup> The Roman traveler, civilian or military, used an itinerary to navigate throughout the empire.<sup>53</sup> Envisioning the Roman world in terms of itinerary instead of a modern map begins to illustrate how important roads were to shaping the perceived geographic boundaries of Roman reach.

Boundaries identify the confines of military operations. Geographic boundaries are the most obvious limits to military operations, but temporal boundaries, frequently represented in the

---

accessible in more recent history, see Randolph B. Marcy, *The Prairie Traveler: A Handbook for Overland Expeditions* (Washington, DC: Authority of the War Department, 1859). Nicholas Purcell, "The Creation of Provincial Landscape: the Roman Impact on Cisalpine Gaul," in *The Early Roman Empire in the West*, ed. Thomas Blagg and Martin Millett (Oxford: Oxbow Books, 2002), 14–15.

<sup>50</sup> This phrasing is adapted from the definition of a map that most U.S. Army NCOs memorize to prove their technical competence. Field Manual 3-25.26 Map Reading, 2-1; Also see, Norman J.W. Thrower, *Maps & Civilization: Cartography in Culture and Society*, Second ed. (Chicago: University of Chicago Press, 1999), 3.

<sup>51</sup> Brian Campbell, "Shaping the Rural Environment : Surveyors in Ancient Rome," *The Journal of Roman Studies* 86 (1996): 88.

<sup>52</sup> Purcell, "The Creation of Provincial Landscape: the Roman Impact on Cisalpine Gaul," 7–8.

<sup>53</sup> Kai Brodersen, "The Presentation of Geographical Knowledge for Travel and Transport in the Roman World: Itineraria non tantum adnotata sed etiam picta," in *Travel and Geography in the Roman Empire*, ed. Colin Adams and Ray Laurence (London: Routledge, 2001), 17.

form of phases and transitions in modern military operations orders, are equally critical in extending operational reach and identifying the culminating point. Planners can think of operational reach as an expression of potential. The physical boundary is the potential in distance and the temporal boundary expresses the potential in terms of duration.

Roman itineraries provide the modern commander with a model for developing temporal boundaries in the form of march tables and capability estimates. The key feature of the typical itinerary was to list the available watering, resting, stopping and animal feeding points along a route coupled with information regarding the distance between these points. Depending on the mode of travel, this allowed Roman commanders to determine the time it would take to move forces between any two locations and the anticipated time it would take for elements of support to arrive. Based on the mode of transport, commanders could determine the number of troops, siege engines, or supplies that their forces could move over the available roads.

It is quite likely that the ancient Roman commander observed his roads and resources and understood something akin to what doctrine calls “tempo” today. Examining tempo, the relative speed and rhythm of military operations, leads naturally into considerations of momentum and endurance.<sup>54</sup> The momentum of a Roman legion, like any object in the physical world, in simple scientific terms is its mass multiplied by its speed. The legion’s endurance was its ability to maintain that mass and speed over time. The Roman road infrastructure provided protection from attack as well as from environmental delays as a means for the legion to maintain both its mass and its speed over time.

These three components, momentum, endurance, and protection, are the subordinate elements of operational reach according to U.S. Army doctrine.<sup>55</sup> Through these elements,

---

<sup>54</sup> United States, *Army Doctrine Reference Publication 3-0: Unified Land Operations*, 4–7.

<sup>55</sup> *Ibid.*, 4–5.

operational reach influences the nature of tasks it is possible to accomplish with a given force. Momentum, being a combination of the mass of the force and the speed, or tempo, of that force's operations, goes a long way to determining how quickly that force can overwhelm enemy resistance. Edward Luttwak discusses the "inevitability" of conquest as a significant factor of the Roman grand strategy. Rome's enemies, Luttwak argues, could see the legions approaching at a deliberate and unstoppable pace and this certainty often caused their capitulation before any engagement ever occurred.<sup>56</sup> When Luttwak calls the victory of the legions inevitable, he is referring to the fact that the enemy force often believed that nothing they could do would stop the legions. Whether or not that belief was true, Luttwak's "inevitability" partially gets at what momentum brings to the force through operational reach.

The nature of Roman military roads ensured the uninterrupted momentum of the force by bypassing minor population centers and deliberately linking the network. By law, all military roads lead to a significant city, another military road, or a seaport. By this design, the Roman legion could march uninterrupted toward their destination, far less likely to lose momentum at chokepoints such as villages or lesser roads.

Like momentum, endurance is a critical component to developing operational reach. Those aspects that ensure that the force can continue to operate, no matter how far they are from their basing, provide the basic foundation of military endurance. U.S. Army doctrine describes endurance as the aspect that "makes permanent the transitory effects of other capabilities."<sup>57</sup> The Romans established logistics in the form of grain supplies, spare horses, and sometimes even lodging along the routes they anticipated traveling. The provinces and colonies often shouldered

---

<sup>56</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 2.

<sup>57</sup> United States, *Army Doctrine Reference Publication 3-0: Unified Land Operations*, 4–5.



the burden of gathering supplies for the army at the far reaches of the empire. In this manner, the Romans ensured the endurance of their forces.

The enemies of Rome sought to disrupt the momentum of the legions and reduce the endurance of the Roman Army. The roads increased the ability of the Roman Army to build and maintain momentum and endurance through improved protection, the final subcomponent of operational reach described in U.S. Army doctrine. Protection entails activities designed to prevent any disruption of operations, whether affected by the environment, the enemy, or an accident.<sup>58</sup>

The road was a useful tool in protecting combat power because it allowed for three major advantages over the enemy. The construction of the Roman roads eliminated delays by taking advantage of terrain. In flat, open land where an unnoticed ambush was not possible, the Roman military roads were famously straight in their course. When commanders and their surveyors and engineers could prevent ambushes successfully through use of defensible terrain, the roads clung to the military crests of ridgelines and valleys. In either instance, the engineers kept the need to be able to easily conduct future reconnaissance in mind when they emplaced the roads.<sup>59</sup>

In another form of protection, the Romans built the roads for travelers to use in all forms of weather. When crossing navigable rivers, the engineers planning the roads ensured the free passage of both the road and the river traffic, equally critical to military operations. When Roman surveyors selected fording points instead of constructing bridges, they chose crossings upstream of high water areas to ensure continued usability even during seasonal rains. The builders carved roads on the sides of mountains with deliberate ruts to keep wheeled traffic from sliding sideways

---

<sup>58</sup> Ibid., 4–6.

<sup>59</sup> Josephus, *The Works of Josephus: New Updated Version Complete and Unabridged in One Volume*, Jewish War 7.8.3; Goldsworthy, *The Roman Army at War: 100 B.C. - A.D. 200*, 108.

during icy conditions. Even the crowned shape of the road's surface was a protection against impasse due to heavy rains.

By the second and third century AD, the Romans augmented the supply stations with a fort system in some areas, which simplified the protection of their forces while on the march. These various forts along the roads often started as overnight sites hastily constructed for the protection of a marching force. In other places, the marching camps of the Roman Army remained the standard for temporary protection.

In every period of Roman activity in Gaul, the nature of lines of communication and basing changed the dynamics of operational reach for the Roman Army. When basing and lines of communication were limited, momentum, endurance, and protection were likewise limited. This, in turn limited the distances and times that bounded possible operations. When basing and lines of communication were well established, the potential momentum, endurance, and protection of the force were not the limiting factors, thereby increasing the potential for operational reach to the full extent that the army was otherwise capable. In the case of the invasion of Britain, where the basing and lines of communication in Gaul benefited from the protection offered by the English Channel, this extended the potential boundary in both time and space. In the case of the frontier, where protection, or a perceived need for protection, hindered all other operations, the boundaries were just as influenced.

Operational reach, supported by basing, defines the potential physical and temporal boundaries of an operation. In addition to physical limitations, boundaries exist in the form of phasing & transitions (restricted by tempo) along the defined lines of operation or effort (which move through decisive points toward an end state determined by the center(s) of gravity). The concept of culmination restricts the extent of these boundaries as a factor of risk that exists along the edge between operational reach and culmination. Momentum, endurance, and protection (elements of operational reach) enable the distance and duration of an operation.

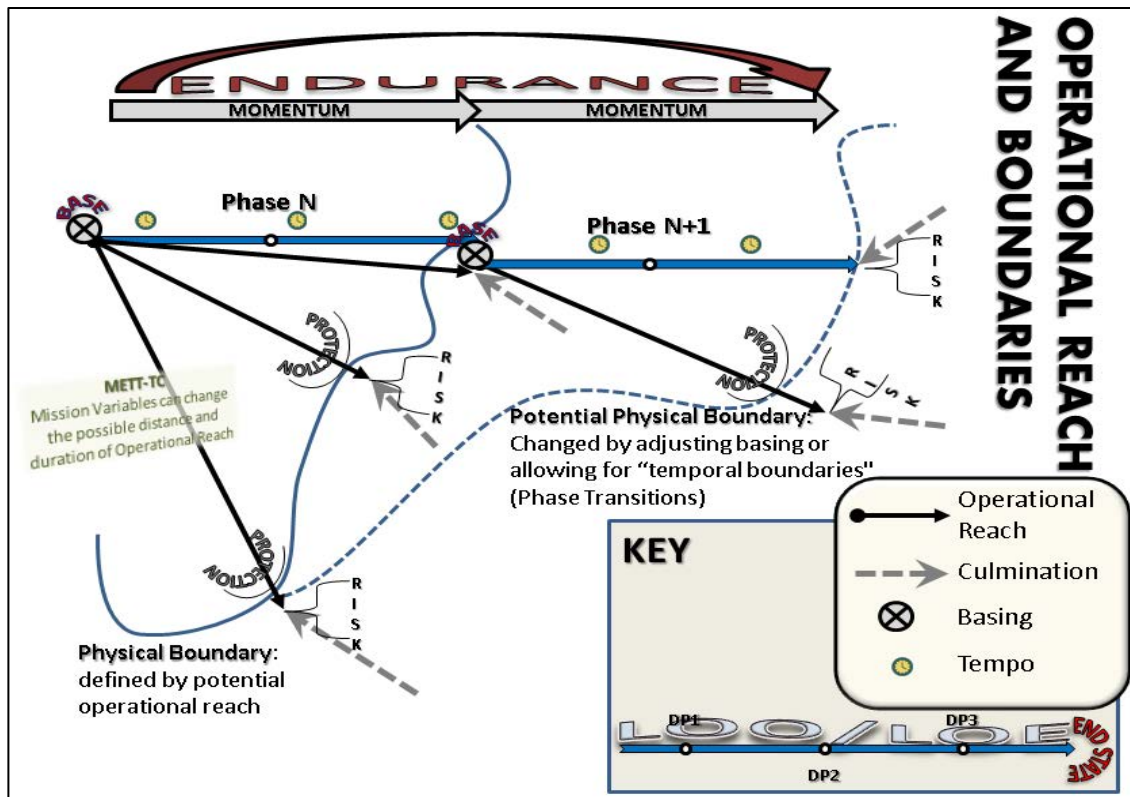


Diagram of how operational reach relates to boundaries

## Julius Caesar over Gallic Roads

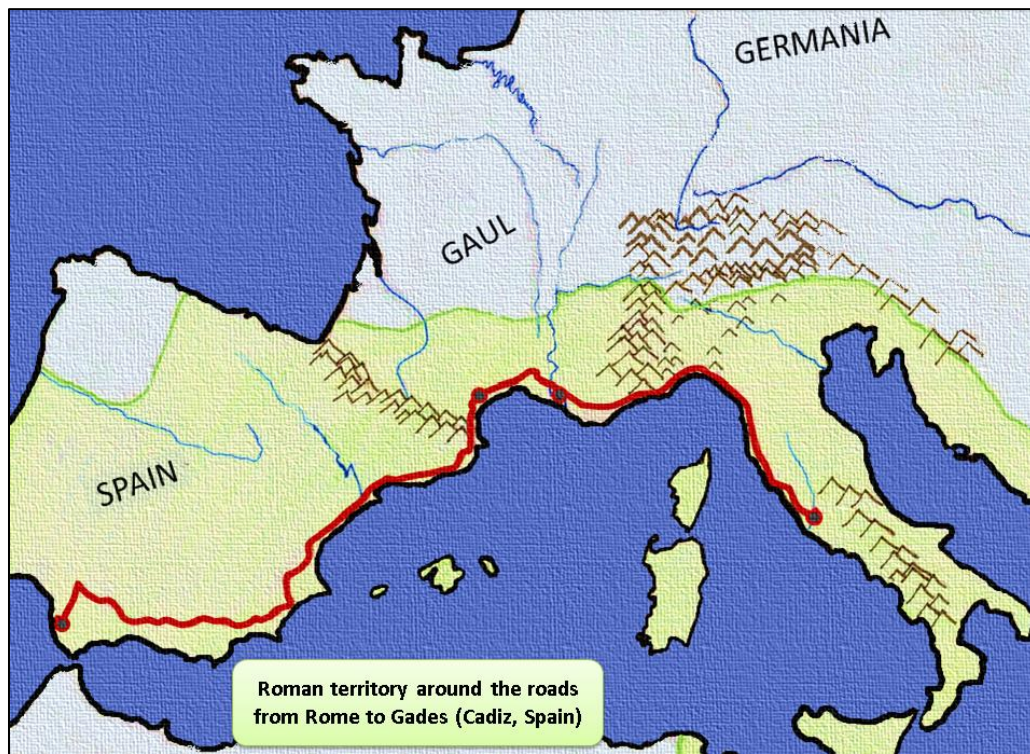
The road the Romans would later name Via Julia Augusta was the coastal route along the edge of the Mediterranean Sea measuring nearly 1300 Roman miles from Rome to the Iberian peninsula.<sup>60</sup> Almost 500 Roman miles of this road stands at the southern edge of Transalpine Gaul.<sup>61</sup> This road was a vital strategic route for maintaining the security and trade of Iberian crops and Roman-Iberian colonies settled in the fertile lands taken during the Punic Wars. Julius Caesar was the Proconsul, or Governor, charged by the Roman Senate with maintaining the security and

<sup>60</sup> Scheidel, Meeks, and Weiland, *ORBIS: The Stanford Geospatial Network Model of the Roman World* calculates these distances at 1924 km from Rome to Carthago Nova on the Spanish coast and 714 miles from the Alps to the Pyrenees; Also see Chevallier, *Roman Roads*, 39. Chevallier explains the source of the Roman mile in 1000 1.48 meter paces (the latin, *mille* for one thousand) which places a Roman mile at 0,92 statute miles.

<sup>61</sup> Vicente González, "GIS and roman ways research in hispania," 14. This article provides tables verifying the given distances from modern satellite-map calculations.

administration of the entire Roman territory from the border of Cisalpine Gaul past the Strait of Gibraltar to the Atlantic Ocean.

Caesar was a politician, and as a politician, he wanted the people of Rome to know what glorious deeds he had accomplished on behalf of Rome. His record of the Gallic Wars, although eventually collected into the single volume we have today, originally manifested as dispatches sent to Rome for the public proclamation of his worthy endeavors.<sup>62</sup> This fact shapes both the nature of Caesar's records and the way in which historians interpret them. It is likely that Caesar embellished his numbers, overstated his cunning, and underplayed his challenges. One of the challenges Caesar may have toned down was moving and feeding his army.



Map of the eastern Roman territory before Caesar's conquest<sup>63</sup>

---

<sup>62</sup> Stephen Dando-Collins, "Caesar's Legion: The Epic Saga of Julius Caesar's Elite Tenth Legion and the Armies of Rome" (Ashland, OR: Blackstone Audio, 2005), 292.

<sup>63</sup> Map is the author's own artwork with reference to: "National Geographic 1: 8,425,000 Scale Map of Europe" (Washington, D.C.: National Geographic Maps, 2011); O'Brien, *Atlas of*

Moving and feeding the Roman Army's legions during the Gallic Wars fell largely on levies from local resources. Beyond the border of the Roman province of Narbonensis, the roads were local tracks suitable for pedestrians, trader's pack animals, and the occasional light cart.<sup>64</sup> Throughout the frontiers of the Roman republic, and later the empire, these small trade tracks frequently became the primary routes of the Roman Army "on the eve of ... conquest."<sup>65</sup> The majority of commerce within Gaul moved by the many rivers that line the countryside.<sup>66</sup>

Although Caesar had no trouble conquering Gaul on Gallic roads, his engineers set to work building causeways, bridges, and roads during the conquest. The very first road he had rebuilt in the Roman style went from Cisalpine Gaul through the Great St. Bernard Pass to Geneva starting in 57 BC.<sup>67</sup> In Transalpine Gaul, the legionary engineers built causeways over swamps in the vicinity of Breuil-le-Sec (Oise) in 52 BC and over marshes near Avaricum (Bourges) by 50 BC in search of greater mobility for the army.<sup>68</sup> Caesar may have used the former of these constructions, two bridges measuring 600 meters in length, to execute a double envelopment against his enemies, the Bellovaci.<sup>69</sup>

One of the most famous feats of construction that Caesar's army ever executed in order to defeat an enemy was building a temporary bridge over the Rhine in 55 BC at the point where the modern day city of Coblenz sits.<sup>70</sup> According to his autobiographical account, Caesar himself

---

*World History*; Cornell and Matthews, *Atlas of the Roman World*; Talbert, *Atlas of Classical History*.

<sup>64</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*, 195.

<sup>65</sup> Chevallier, *Roman Roads*, 15.

<sup>66</sup> G.R. Crone, "The Site and Growth of Paris," *The Geographical Journal* 98, no. 1 (1941): 35–47.

<sup>67</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*, 195.

<sup>68</sup> Forbes, "The Topography of Caesar's Last Campaign against the Bellovaci," 204.

<sup>69</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*, 195–196.

<sup>70</sup> Chevallier, *Roman Roads*, 173.

designed the bridge to withstand the strong current by placing additional pylons upstream of the actual bridge supports.<sup>71</sup> The bridge, which the legions erected in just ten days, stood for eighteen days while the legions plundered the far shore and then, once safely back across, Caesar had it torn down.<sup>72</sup> He repeated the feat in 54 BC to demonstrate the power of Rome to the Germans along with adding even greater publicity to his own name.<sup>73</sup>

Despite its significant engineering capacity, Caesar's army relied heavily on levied supplies from the local friendly tribes as well as some supplies captured or ransomed from defeated enemies. Caesar's own accounts of battles almost always begin with an account of how he managed the feeding of the army and guaranteed their supply before he set out for the engagement.<sup>74</sup> This was a logical priority for the Roman Army so deep in undeveloped territory and reliant on rough, narrow roadways. They were operating at a great distance from any friendly basing and over limited lines of communication.

In the winters of 57-52 BC between campaigns, these challenges only increased. Caesar felt that he could not afford to withdraw his entire army from newly captured territory in northern Gaul to go into winter quarters in a more preferred location, such as Narbonensis, thus the army suffered from hastily constructed basing due to this constraint.<sup>75</sup> Although sustaining the legions fell to the local tribes as a sort of punishment for resisting conquest, the legions were far from being able to mutually support each other in their distant winter quarters in northern Gaul.<sup>76</sup>

---

<sup>71</sup> Caesar, *The Complete Works of Julius Caesar*, Gallic Wars 4.17.

<sup>72</sup> Kate Gilliver, Adrian Keith Goldsworthy, and Michael Whitby, *Rome at War: Caesar and His Legacy* (Oxford: Osprey Publishing Limited, 2005), 46, 55–58.

<sup>73</sup> Caesar, *The Complete Works of Julius Caesar*, Gallic Wars 6.9.

<sup>74</sup> Ibid., Gallic Wars 1.16, 23, 37, 49. In each of these instances, Caesar puts his concern for feeding his army before the rest of his account. This list is by no means exhaustive.

<sup>75</sup> Gilliver, Goldsworthy, and Whitby, *Rome at War: Caesar and His Legacy*, 52, 55.

<sup>76</sup> Caesar, *The Complete Works of Julius Caesar*, Gallic Wars 3.2.

The general expense in time, labor, and supplies hindered Caesar's options no matter how successful his actual campaigns were in the execution. At each turn, Caesar not only had to conquer a new enemy but also negotiate a new source of food and supplies. Military historians often laud Caesar as one of history's greatest generals. Caesar even makes the great military theorist, Carl von Clausewitz's short list of superior commanders that includes Alexander the Great, Gustavus Adolphus, and Napoleon Bonaparte.<sup>77</sup> In that same section, Clausewitz argues that, for soldiers, hardships overcome are just as challenging as dangers faced. For Caesar, he deserves a reputation of greatness just as much for overcoming the hardship of supporting his forces in the far reaches of Gaul, as he deserves one for conquering the many warlike tribes of that country.

A lack of basing and a nascent network of usable roads and bridges limited the operational reach of Caesar's legions in Gaul. Because their operations led them to continually blaze trails and build bridges or causeways to reach their enemies, the legions had limited momentum during their operations. They were not able to maintain forward motion in a manner that always "overwhelmed the enemy's resistance."<sup>78</sup> The shortfalls in food and supplies often cut the overall endurance of the force and operations could not begin until Caesar or his subordinate commanders could feed the army.<sup>79</sup>

The enemy was often able to threaten the protection of the legions despite their ability to readily construct hasty fortifications and encampments. The enemy repeatedly circumvented the basic security measures of the army and Caesar often records instances where his army narrowly

---

<sup>77</sup> Carl Von Clausewitz, *On War*, trans. Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), 189.

<sup>78</sup> United States, *Army Doctrine Reference Publication 3-0: Unified Land Operations*, 4–5.

<sup>79</sup> Caesar, *The Complete Works of Julius Caesar*, Gallic Wars 1.23.

escaped an ambush or hastily defeated an enemy at the gates of their encampments.<sup>80</sup> Caesar's operations provide a glimpse of how tightly commanders must manage the particular risk that arises when a force is operating at the edge that exists between operational reach and culmination.

Continual challenges to momentum, endurance, and protection limited Caesar's ability to quickly defeat his enemy despite the superior tactics and training of the Roman legions. His success despite an insufficient system of support stands as a testimony of his generalship. The limitations that Caesar faced that restricted his potential operational reach disappeared in due time as all of Gaul became a conquered and settled province of Rome. The legions and other forces of Rome immediately began improving lines of communication and basing while increased taxation and economic success led to a greater grain output in Gaul itself.<sup>81</sup>

## **Toward Britain over Gallic Roads**

Almost a hundred years passed between Caesar's initial invasion of Britain in 55 BC and the Claudian conquest begun in 43 AD. During that century the Roman Army, the slaves of the empire, or other local labor laid hundreds of miles of military, public, and private roads without much fanfare or significant record keeping. The milestones archaeologists have discovered along the ancient ruins of Roman roads provide some occasional information about who paid for the roads and which legions may have labored in their construction. No scholar has ever discovered a grand design of the Roman roads but many have taken a map and studied how the routes radiate from key cities or converge on key ports to form an apparent design.<sup>82</sup>

---

<sup>80</sup> Ibid., 3:6, 19, 25; 6:42; 8:12, 17, 18.

<sup>81</sup> J.F. Drinkwater, "For Better or Worse? Towards an Assessment of the Economic and Social Consequences of the Roman Conquest of Gaul," in *The Early Roman Empire in the West*, ed. Thomas Blagg and Martin Millett (Oxford: Oxbow Books, 2002), 211.

<sup>82</sup> Chevallier, *Roman Roads*, 81; Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 96; Casson, *Travel in the Ancient World*, 122.



Two reasons exist for this pattern. First, the natural waterways of Gaul influenced both the placement of the roads and the locations of the population centers. Where rivers branch or near each other, there is a logical location for a significant settlement to arise.<sup>83</sup> Later, the great architect of Augustus's Rome, Marcus Vipsanius Agrippa, did design some of the roadways of Gaul.<sup>84</sup> Caesar Augustus appointed him to the task sometime after the young emperor's personal tour of Gaul in 27 BC. Agrippa, who arrived in Gaul on 9 June 19 BC, took the task of engineering new highways where necessary and incorporating pre-existing roads where he could.<sup>85</sup>

Although the general credit goes to Agrippa, the exact record of the construction for the many Roman roads coursing the avenues into and through Gaul is a difficult puzzle to piece together. It starts with the history of the general construction of Roman roads. The Roman engineers were the "inventors and perfecters [sic] of the deep-laid road-bed and the cambered paved road," which separates the Roman roads from the pre-existing Gallic roads.<sup>86</sup>

Several sources document the method of the actual construction that the Romans used.<sup>87</sup> The first step the Roman surveyors would undertake was to mark the road's path with either stakes or furrows made as straight as possible through the use of line of sight measuring tools.<sup>88</sup> Following the setting of the path, the laborers, often legionaries or slaves belonging to the army,

---

<sup>83</sup> Crone, "The Site and Growth of Paris," 36. Lutetia (Paris) provides just one example of a settlement influenced by the joining of rivers and land routes.

<sup>84</sup> Goldsworthy, *In The Name of Rome: The Men Who Won the Empire*, 270, 275.

<sup>85</sup> Chevallier, *Roman Roads*, 160; Von Hagen and Tomeucci, *The Roads that Led to Rome*, 198.

<sup>86</sup> *Ibid.*, 24.

<sup>87</sup> I.A. Richmond, "Notes on the History of Ancient Roads and Their Construction by R. J. Forbes Review," *The Journal of Roman Studies* 25 (1935): 113–114; J.B. Ward Perkins, "Etruscan and Roman Roads in Southern Etruria," *The Journal of Roman Studies* 47, no. 1 (1957): 139–143; Chevallier, *Roman Roads*.

<sup>88</sup> Cornell and Matthews, *Atlas of the Roman World*, 184, 100–101.

dug a trench that was commonly 1.5 meters deep for the width of the road. Then laborers filled and packed the trench with material that the engineers had hauled in so as to be of a different texture and type from the land around it. This ensured the firmness and durability of the substrate. After laying a base, the Romans applied a layer of gravel or pavestones ensuring that the road had a camber, or rise in the center, to prevent erosion and make the surface all-weather capable.<sup>89</sup>

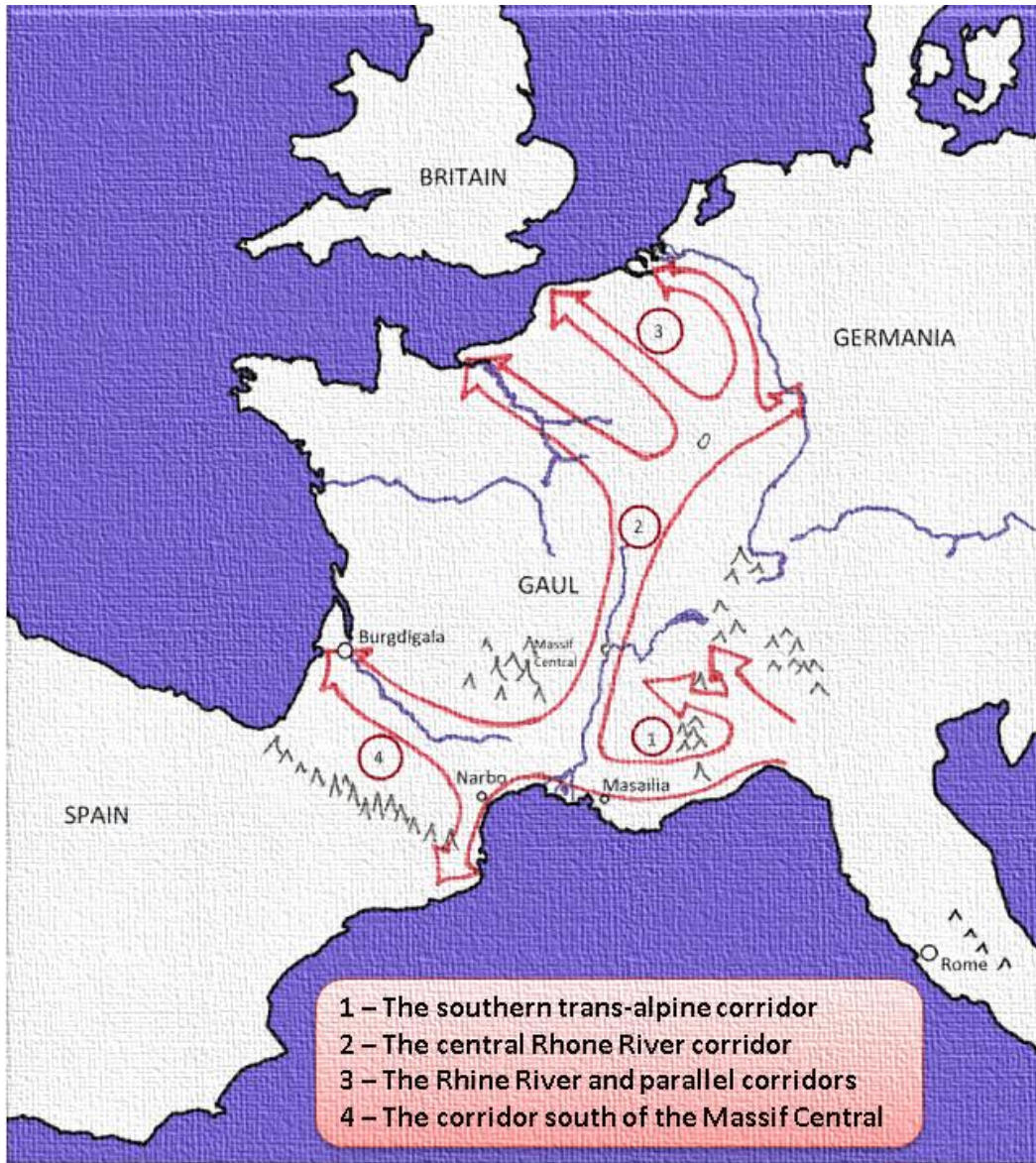
Roman laws directed engineers and surveyors to use the type and straightness of the road to determine the required width of the constructed surface.<sup>90</sup> Archaeological evidence suggests that the builders rarely constructed the roads to the specifications laid out according to these decrees. The military roads (*ordines maximus* here) were supposed to be twelve feet wide and twenty feet at intersections and junctions. This width would ensure that the army and its baggage train could march along it without slowing down to manage their various wheeled equipment at bends in the road and intersections. It is important to remember that the pivoting axle, which allowed for much narrower turns, was not invented until the Renaissance.<sup>91</sup>

---

<sup>89</sup> Chevallier, *Roman Roads*, 83.

<sup>90</sup> *Ibid.*, 88.

<sup>91</sup> *Ibid.*, 12, 89, 179–181 Chevallier also notes that the wagon wheels were too high above the frame to allow for easy turning; For more on how the springless, pivotless wagon impacted travel, see Casson, *Travel in the Ancient World*, 180.



**Map of the four major transportation corridors in Gaul<sup>92</sup>**

In Gaul, there are four major transportation corridors, mostly following river valleys, that the Roman Army used to move men, animals, equipment, and supplies along the invasion routes toward Britain. The Via Julia Augusta, which traced the coast south of the Alps into the ancient city of Massilia (Marseille) and then on to the colony at Narbo (Narbonne), was the primary

<sup>92</sup> Map is the author's own artwork with reference to: "National Geographic 1: 8,425,000 Scale Map of Europe"; O'Brien, *Atlas of World History*; Cornell and Matthews, *Atlas of the Roman World*; Talbert, *Atlas of Classical History*.

artery over which communications from Rome traveled. This route, coupled with other passes over the Alps, formed a backbone of Narbonensis Province. As the strongest foothold of Rome in Gaul, it supported the trade and military transport that passed North and West onto the other avenues.

The next major avenue to consider was the route that followed the Rhone river valley north through Lugdunum (Lyon) and along the Saone and Mosel rivers to the west bank of the Rhine. This north-south route cut between the Alps and the Massif Central to establish a link between the Mediterranean world and the province of Belgica as well as Germania Inferior. Most of the commercial traffic that traveled this route would have been waterborne for the majority of the journey. The Romans almost certainly built military roads on top of older Gallic dirt roads along any of the routes that trace the rivers of Gaul.

In order to reach the sea by road, three routes roughly paralleled the Rhine. The northernmost was a road along the banks of the Rhine itself, probably used to manage river cargo as well as to allow for traffic. A central route passed from Durocortorum (Reims) to Gesoriacum (Calais) which would have been the shortest and most logical for any travel that did not need rivers. Further south, the Romans built a route to the sea by way of the Seine that passed through the central hub at Lutetia (Paris) which supported traffic from the Marne as well.

The fourth route that traffic intended for the invasion of Britain traveled was a link south of the Massif Central from Narbo (Narbonne) to Burdigala (Bordeaux). This route became a supplementary axis for auxiliary soldiers and supply traffic. Interestingly, the elephants that the Romans deployed to Britain came along this southern route to keep them from harsher weather during the preparations.<sup>93</sup>

---

<sup>93</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*, 210–213.

The rivers that most of these routes follow carried traffic for hundreds of years before laborers placed the first pavestone and they continue to do so today.<sup>94</sup> The reason that the roads become interesting is that the legions favored marching to riding in riverboats.<sup>95</sup> The costs in both time and money of shipping soldiers around the empire would have been prohibitive. In addition, most scholars agree that the generals considered marching part of the training and fitness of their soldiers.<sup>96</sup> Customarily, if Rome's soldiers used boats in any great numbers, they embarked at a seaport in order to conduct some form of operation across the sea.

In the case of Gaul, the four major avenues identified not only follow rivers, but they also head either to major hubs or to the sea. The cities and ports of Gaul, already influenced in their location by the natural terrain and rivers, may have additionally influenced the apparent patterns of the road network throughout the provinces.

While most historians accept that there was no deliberate grand scheme for the Roman roads, any city the Romans built or rebuilt followed a very common and deliberate plan. Many of the fortified cities of the Roman empire share the same features despite the terrain around them. These common points, including aqueducts and public baths, almost always fit within a four-wall square with a gate in the center of each side. These gates, as the only entry and exit points for the military, population, and commerce forced a certain configuration with roads exiting in a crow's foot pattern from each gate.

The ports grew near the mouths of the rivers that the roads followed because those locations offered both a natural harbor and direct access to the line of commercial and military traffic. Ports on the Mediterranean were especially important to the empire because without

---

<sup>94</sup> "National Geographic 1: 8,425,000 Scale Map of Europe"; Chevallier, *Roman Roads*, 160.

<sup>95</sup> Casson, *Travel in the Ancient World*, 130, 164.

<sup>96</sup> Renatus, *Military Institutions of the Romans*, 30–31; Polybius, *The Rise of the Roman Empire*, trans. Ian Scott-Kilvert (London: Penguin Books LTD, 1979), 335–338; Goldsworthy, *The Roman Army at War: 100 B.C. - A.D. 200*, 110.

traffic across the inland sea the empire became a giant hollow ring that was virtually impossible to supply, defend, or communicate within.<sup>97</sup>

In this manner, the Romans, who did not view themselves as a sea faring people, had the confidence to reach across the English Channel toward the source of tin that their weapons and tools required so badly. The Roman roads were in place throughout Gaul and the invasion forces easily moved work force, equipment, and supplies to northern and western ports in order to mount an invasion in the summer of 43 AD. Gaul, which started as a region of troublesome tribes beyond the key province of Narbonensis, had become such an integral part of the Roman empire in the century after its conquest that it was now a projection platform for invasion into Britain.

Improvements in the basing and lines of communication within Gaul had a direct effect on the potential operational reach that the Roman legions could gain and maintain from the shores of Gaul toward operations in Britain. This provides a clear example of how a shift of basing toward a forward point along the line of operation shifts the potential physical and temporal boundaries. All-weather Roman roads allowed the legions to maintain their operational endurance throughout the period leading up to the invasion and the invasion itself. Multiple avenues meant that Roman commanders could collect their forces quickly from throughout the empire and ensure that the invasion carried the necessary momentum to quickly overwhelm the peoples of Britain. The English Channel itself served the function of protection for the basing and lines of communication within Gaul.

Hence, a more mature infrastructure completely changed the extent of temporal and physical boundaries in relation to potential operational reach and culmination for forces preparing to invade Britain. This particular operation moved the boundary of the empire itself and allowed a

---

<sup>97</sup> Adrian Keith Goldsworthy, "Roman Warfare," *NYMAS Friday Evening Talk*, 2013, <http://nymas.org/podcasts/AdrianGoldsworthy-RomanWarfare160kbps.mp3> (accessed July 4, 2013).

significant gain in both territory and resources; although scholars must also try to understand the final location at Hadrian's Wall in relation to factors that influenced the operational reach on the British isles themselves.<sup>98</sup> To better understand the nature of operational reach in relation to a fixed boundary, the Germanic frontier provides a ready example.

## **The Germanic Frontier over Gallic Roads**

Strategic requirements defined the greater shape of the frontiers of the Roman empire more often than operational or tactical concerns.<sup>99</sup> However, it was at the local tactical and operational level that the specific location of fortifications and roads both determined and depended on the operational reach available for logistical support and reinforcement. These factors often shifted depending on the availability of forces and the policies of the empire while another influence on the local dynamics of operational reach came from the shape of the frontier.

The Germanic frontier adjacent to Gaul was mostly what scholars know today as the Rhineland and consisted of Germania Superior and Germania Inferior along the western bank of the great Rhine River. The Rhine runs from the Swiss Alps north to North Sea. The headwaters of the Rhine pass less than twenty Roman miles from the headwaters of the Danube, which itself formed another portion of the imperial frontier. Because the terrain between the Danube and the Rhine formed an odd corner in the Roman frontier, the locations of the fortifications along this portion changed occasionally between the first and third centuries. For security purposes, the Army first expanded the boundary to the eastern side of the Rhine between 73 and 85 AD during the reigns of Vespian and Domitian.<sup>100</sup> This southern portion of the Rhine frontier continued

---

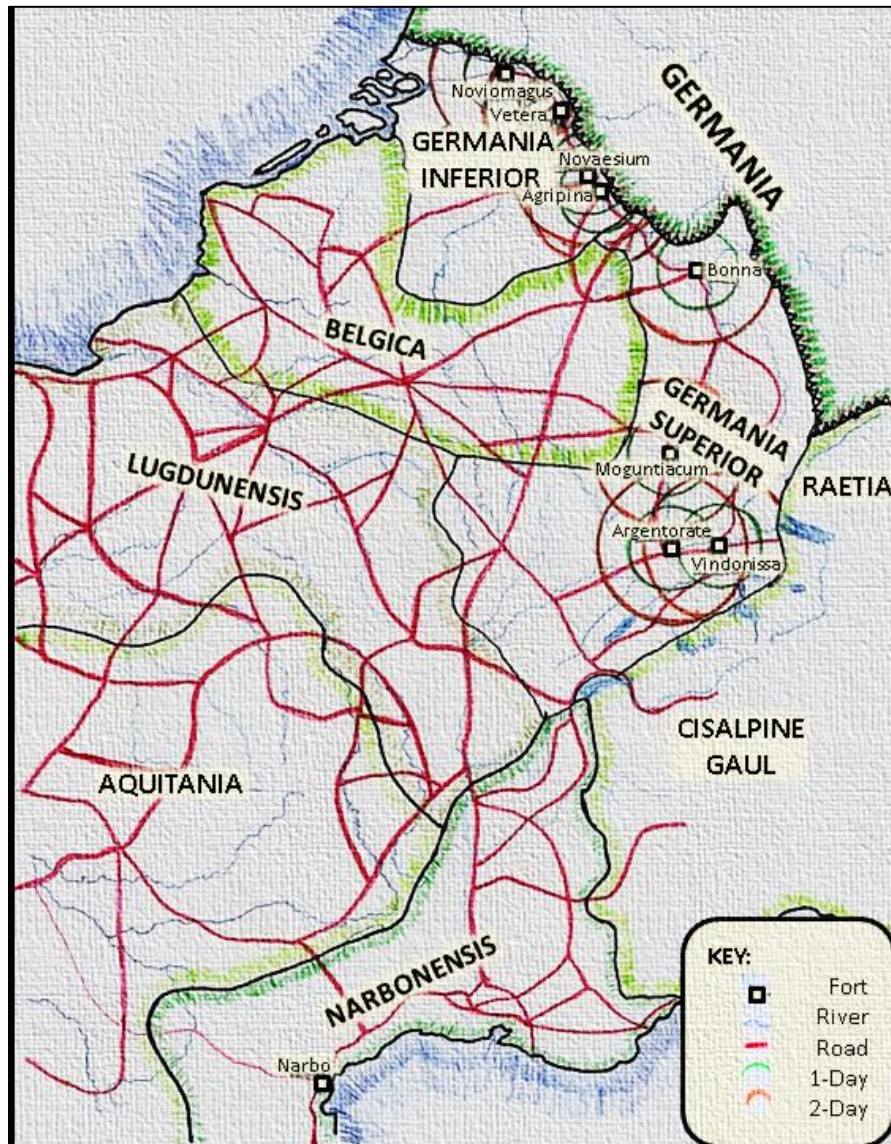
<sup>98</sup> The operational reach of the Roman army on the British isles is a topic to save for another study.

<sup>99</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 104. Luttwak uses Emperor Trajan's Dacian campaign to illustrate the strategic priority over the tactical in the shape of the frontier.

<sup>100</sup> Cornell and Matthews, *Atlas of the Roman World*, 107; Talbert, *Atlas of Classical History*, 137; Goldsworthy, *In The Name of Rome: The Men Who Won the Empire*, 359.



downstream until the city of Moguntaicum (Mainz), which sits across from the Main River, where the provincial boundary became the Rhine River itself. The territory of Germania Superior ends shortly north of the colony of Confluentes (Coblentz), where the Mosel River's confluence still swells the river today.



Map of the Rhine frontier, circa 100 AD<sup>101</sup>

<sup>101</sup> Map is the author's own artwork with reference to: "National Geographic 1: 8,425,000 Scale Map of Europe"; O'Brien, *Atlas of World History*; Cornell and Matthews, *Atlas of the*



Germania Inferior begins where the increased volume of the river, so beneficial to the volume of modern river traffic, added to navigational capacity for transportation in the early imperial period as well.<sup>102</sup> In contrast to the higher possibility for cargo vessels, the challenge of fording or bridging the wider, faster river increased significantly. The Rhine made a sufficient border in Germania Inferior due to the significant obstacle it presented any possible enemies. The river shaped a south-to-north line through the Roman cities of Colonia Agrippina (Köln), Novaesium (Neuss), and Vetera (Xanten) where it turned west toward the sea.<sup>103</sup>

Julius Caesar first crossed the Rhine River in 55 BC and forces under Emperor Augustus first attempted to seize and permanently maintain territory on the eastern side around 15 BC.<sup>104</sup> This colonization was initially successful and continued until 9 AD when Arminius, a Germanic noble who trained in a Roman auxiliary unit and even held Roman citizenship, handily defeated Publius Quinctilius Varus, a political appointee in command of three legions, at the battle of Teutoberg Forest, which triggered a change in policy for the empire.<sup>105</sup> This significant and unexpected defeat influenced a change in public and political perspectives in Rome that led to the establishment of the Rhine River line as the frontier border with tribes of Germania, who the Roman public then viewed as less malleable than Roman influence could overcome.<sup>106</sup>

---

*Roman World*; Talbert, *Atlas of Classical History*; Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*.

<sup>102</sup> Brogan, "Trade between the Roman Empire and the Free Germans," 195; Straker and Margary, "Ironworks and Communications in the Weald in Roman Times," 55.

<sup>103</sup> Cornell and Matthews, *Atlas of the Roman World*, 128–129. The map on these two pages provided the all of the place names in the preceding two paragraphs.

<sup>104</sup> Talbert, *Atlas of Classical History*, 139.

<sup>105</sup> Jürgen Kunow, "Relations between Roman occupation and the Limesvorland in the province of Germania Inferior," in *The Early Roman Empire in the West*, ed. Thomas Blagg and Martin Millett (Oxford: Oxbow Books, 2002), 88–90; Goldsworthy, *In The Name of Rome: The Men Who Won the Empire*, 276.

<sup>106</sup> H.H. Scullard, *From Gracchi to Nero: A History of Rome from 113 B.C. to A.D. 68*, 5th ed. (London: Routledge, 1982), 259.

The lack of operational reach available without sufficient roads in German terrain limited Claudius Germanicus Caesar's (commonly known as Germanicus) subsequent campaigns across the Rhine in the first century AD. He successfully captured terrain in three consecutive years between 14 and 16 AD but every time his supply lines, heavily reliant on North Sea shipping, could not support his legions through the harsh German winter in the face of a hostile enemy.<sup>107</sup> After the third attempt, Emperor Tiberius Caesar ordered Germanicus to focus his energies on securing the frontier of Gaul.<sup>108</sup> Tacitus, a premier Roman historian of the early empire, speculated that jealousy of the younger man's political fame influenced Tiberius' decision but others have argued that the decision saved Rome the remaining eight legions stationed on the Rhine from utter waste and destruction for land that appeared too costly to the Romans.<sup>109</sup>

During the reign of Tiberius from 14-37 AD, the boundaries of Rome along eastern Gaul became fixed in accordance with one of the final enunciations of Caesar Augustus, declaring that the empire had reached perfection and that his successors should not seek further conquest.<sup>110</sup> In this sense, for at least one of the borders of the Roman empire, scholars can appreciate how writers such as Tacitus came to view the borders as a reflection of the natural boundary of Rome "aided by oceans, deserts, and rivers."<sup>111</sup> The shape of the Germanic frontier shifted mildly over the following centuries, usually toward expansion, but never by any significant amount like the Danube frontier along Dacia or the territory north of Hadrian's wall. The fairly static nature of the

---

<sup>107</sup> Tacitus, *The Complete Tacitus Anthology*, Annals 1.3.

<sup>108</sup> Kunow, "Relations between Roman occupation and the Limesvorland in the province of Germania Inferior," 90; Scullard, *From Gracchi to Nero: A History of Rome from 113 B.C. to A.D. 68*, 270–271.

<sup>109</sup> Ibid., 271, 279; Caesar, *The Complete Works of Julius Caesar*, Gallic Wars 4.3. Caesar implies that the territory of Germania was not only difficult to conquer, but also perhaps not worth the effort.

<sup>110</sup> Benjamin Isaac, "The Meaning of the Terms Limes and Limitanei," *The Journal of Roman Studies* 78 (1988): 125.

<sup>111</sup> Scullard, *From Gracchi to Nero: A History of Rome from 113 B.C. to A.D. 68*, 259.

Germanic frontier makes it the ideal location for exploring the type of defensive network the Romans constructed behind their borders.

Roman generals often accomplished the establishment of frontier fortifications through military action which Edward Luttwak labeled “engineering offensives.”<sup>112</sup> For example, Vespian’s legions erected fortifications at key points on the banks of the Rhine immediately after quelling a revolt in 70 AD. The fortifications at Argentorate (Strasbourg) and Monunthiacum (Mainz) became permanent border fixtures in this manner before they became prominent colonies.<sup>113</sup> This type of engineering operation would have initially appeared very similar to the way in which the Romans established daily, fortified, marching camps.

This Roman practice, as supported by multiple accounts and archaeological records, was much like a modern standard operating procedure ensuring that the legion on the march established a fortified camp at the end of each day’s march.<sup>114</sup> Unless pressed by some extenuating circumstance, the legions almost always formed the marching camp according to the same general design. The layout required that legionaries level the ground, dig a trench four to five feet deep using the removed dirt to form a rampart, then erect a temporary four-walled perimeter fence with gates in roughly the same location every time. The army always erected the general’s tent and headquarters at the intersection of a T-shaped roadway connecting the three primary gates inside the camp. Not only did the soldiers’ tents fall into the same pattern in every marching camp, but it is also highly probable that each individual soldier slept in the same location within the camp each night, although another twenty to twenty-five Roman miles further

---

<sup>112</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 89.

<sup>113</sup> *Ibid.*, 92.

<sup>114</sup> Goldsworthy, *The Roman Army at War: 100 B.C. - A.D. 200*, 111–115; Ernst Fabricius, “Some Notes on Polybius’s Description of Roman Camps,” *The Journal of Roman Studies* 22, no. Part 1 (1932): 78–87; Alan F Leslie, “Roman temporary camps in Britain,” *Corpus*, 1995, <http://theses.gla.ac.uk/789/>.

down the road.<sup>115</sup> Philip Matyzak highlights that the same eight-legionary squad (*contubernium*) who shared barracks space together in a permanent fort would have shared a tent in the marching camp.<sup>116</sup>

Although multiple specific variations existed, the basic form of most Roman fortifications in the first centuries of the empire followed the same pattern as the marching camps.<sup>117</sup> Each was generally square with three primary gates (a fourth gate was often hidden) serviced by a T-shaped road and the headquarters seated at the intersection. This same four-walled shape formed the basis for early Roman veterans' colonies and fortified cities established near the frontier as well.<sup>118</sup>

The critical link between these fortifications and settlements along the frontier was a network of roads. The Latin name for the frontier, *limes*, was originally one of the words used to designate a military road from ordinary public roads.<sup>119</sup> The road network between the various fortifications and settlements along the frontier line was critical to its successful operation and may have defined the exact function of various forts along the frontier. Luttwak describes the tactical operation of the frontier in terms similar to a defense in depth. The various forces on the actual border watchtowers provided early warning and initial response while forces stationed behind the actual frontier line served as a reserve. In the case of a great enough hostile force

---

<sup>115</sup> Goldsworthy, *The Roman Army at War: 100 B.C. - A.D. 200*, 113.

<sup>116</sup> Matyzak, *Legionary: The Roman Soldier's (Unofficial) Manual*, 117.

<sup>117</sup> Campbell, *The Roman Army, 31 BC-AD 337: A Sourcebook*, 80–81.

<sup>118</sup> R.E.M. Wheeler, "The Roman Town-Walls of Arles: and a Note on Other Roman Town-Walls in Gaul and Britain," *The Journal of Roman Studies* 16 (1926): 174–193; Brian Campbell, "Who Were the 'Viri Militares'?", *The Journal of Roman Studies* 65 (1975): 11–31.

<sup>119</sup> Isaac, "The Meaning of the Terms *Limes* and *Limitanei*," 126; Tacitus, *The Complete Tacitus Anthology*, Annals 1.50.

breaching the border, commanders could call upon forces from the various fortifications along the entire frontier within the province to defend the empire.<sup>120</sup>

The Romans first supported the initial establishment of the frontier line using available rivers and trading paths for transportation and then began to improve the roads that supplied their forces on the border. As the roads in Gaul improved over time, the Germanic frontier gained prominence as both a critical area to support for military security and a significant transportation link through the Rhine and various other rivers that passed into Gaul and the Alps. Ample all-weather roads always paralleled these key river routes to support government and military traffic alongside the commerce on the water.

As the road network developed, the stations supporting the public courier service (which was only public in the sense that it served the emperor) was a significant foundation for the support network that grew along the roads.<sup>121</sup> Augustus created Rome's public courier (*cursus publicus*) system and it developed into a network of roadhouses that allowed any courier with the correct documentation to demand food, water, shelter and fresh horses along each road while carrying messages to or from the emperor.<sup>122</sup> As the empire progressed, the authority to use this network expanded to include messengers serving provincial governors, senators, generals, and a number of other officials.<sup>123</sup> The capacity also expanded to include the movement of cargo and the availability of entire wagon teams at many of the weigh stations along the routes.<sup>124</sup>

---

<sup>120</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 61–80.

<sup>121</sup> Mitchell, "Requisitioned Transport in the Roman Empire : A New Inscription from Pisidia," 129–130.

<sup>122</sup> Casson, *Travel in the Ancient World*, 182–190; Ramsay, "The Speed of the Roman Imperial Post," 64–70.

<sup>123</sup> Casson, *Travel in the Ancient World*, 183–184.

<sup>124</sup> Ibid., 182–183; F.F. Bruce, *The Canon of the Scripture* (Downers Grove, IL: InterVarsity Press, 1988), 203–205. F.F. Bruce retells how Emperor Constantine used the public courier to transport 50 bound copies of the Bible to various churches throughout the empire;

The expansion of the public courier is important because its expansion led to an overall expansion of food and quarters available to soldiers who traveled Rome's roads as well as an increase in the movement of supplies for the army over the road network. The army still acquired most of its food and supplies locally at the provincial level but with the expansion of the courier network, provincial governors had a double reason to designate a location as a grain store along the routes both couriers and armies traveled.<sup>125</sup>

The static army of the frontier primarily conducted two types of tactical actions. First, its task was to defend the borders against raiding and attacks. Often the raiders, seeking plunder, would cross the frontier too quickly for the army to stop them, but when the raiding party attempted to return across the frontier weighed down by loot and plunder, the army was there to make sure that the invaders left empty handed.<sup>126</sup> If cross border raids became a significant issue, the army was usually prepared to conduct its second most common type of operation, the punitive expedition. The targets of punitive expeditions were not always raiding tribes but frequently occurred within the empire against various internal uprisings and rebellions.

These two types of expeditions required a capability for mutual support amongst the various military fortifications along the frontier lines. Starting in the early first century AD there were between four and eight legions stationed along the Germanic frontier.<sup>127</sup> In addition to this,

---

Mitchell, "Requisitioned Transport in the Roman Empire : A New Inscription from Pisidia," 129–130.

<sup>125</sup> R. Quick and Stephen J. Simon, "Wheat production and the Romanization of northern Gaul," *The Ancient world* 30, no. 1 (1999): 59–62; Kate Britton and Jacqui Huntley, "New evidence for the consumption of barley at Romano-British military and civilian sites, from the analysis of cereal bran fragments in faecal material," *Vegetation History and Archaeobotany* 20, no. 1 (2011): 41–52, <http://www.springerlink.com/index/10.1007/s00334-010-0245-3>; Mitchell, "Requisitioned Transport in the Roman Empire : A New Inscription from Pisidia," 129–130.

<sup>126</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 69.

<sup>127</sup> Hammond and Scullard, *The Oxford Classical Dictionary*, 591–593; Matyszak, *Legionary: The Roman Soldier's (Unofficial) Manual*, 198; Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 85, 119–125. Luttwak also explores the

archaeological evidence shows that forts manned by locally recruited auxiliary troops filled the gaps between legionary forts. The legions themselves started out fortified as paired legions to ensure enough combat power was on the ground.<sup>128</sup> Eventually, the necessity to cover more ground outweighed the risk to the legions and the Romans constructed separate forts for units smaller than the cohort, which would have been similar in manpower to a modern reinforced company. This separation was possible because the road network between the various elements stationed on the frontier improved to the point that swift mutual support was possible.

In this way, the Germanic frontier became the stationary border of the Roman empire. This period's application to operational reach may not be as obvious in the first reading, but operational reach is composed of momentum, endurance, and protection. The Germanic frontier exchanged almost all possibility of momentum for a substantial increase in endurance and a significant increase in protection to the greater empire. This allowed Rome to dedicate its resources to maintaining the borders and policing the interior regions without expending far greater resources on conquest of lands that were beyond their perceived natural borders.

This look at the Germanic frontier opens the concept of operational reach to a consideration of the nature of the interplay of its components. The increase in one element, in most cases, will cause the drop of another unless technology or infrastructure increases them all. On the static frontiers of the Roman empire, the army greatly reduced the potential momentum of its forces as a trade-off for greater endurance and protection.

---

changing structure of the legions that changed the number of men on the line without necessarily effecting the number of legions.

<sup>128</sup> Ronald Syme, "Rhine and Danube Legions under Domitian," *The Journal of Roman Studies* 18 (1928): 43–44. Syme also offers some other explanations for why the double-legion forts ended. In his view they contributed to the revolts in the late first century.

## Conclusion: The Operational Reach of Rome

At the height of the empire, circa 250 AD, the taxpayers and officials of Rome maintained over fifty-three thousand miles of public roads.<sup>129</sup> Twenty of these started at the city of Rome and branched from there into over 300 named roads throughout the provinces, possessions, and territories of Rome.<sup>130</sup> Stanford University's Geospatial Network Model of the Roman World indicates that at the height of the road network's completeness, the mid third century AD, the legions could reach the greatest distances within the empire during winter in around sixty days. This estimate assumes the legions sat at the center of the empire, but Rome kept them deployed to the troubled periphery, which made the necessary travel time even shorter for the leading reactionary force to arrive in a contested area.

Road networks and the way stations of the public couriers functioned so that couriers could take messages to and from the emperor in as little as twelve days' time even to the farthest reaches such as Hadrian's Wall.<sup>131</sup> Between the dispersion of the army and the communication capability of the Roman emperors, the Roman road network was critical to the ability of twenty-eight legions, paired with an auxiliary of similar size, to secure the entire Roman empire from external and internal threats.<sup>132</sup> That these roads were more useful for this task once they were all weather and purpose-built for the traffic required to sustain warfare supports some important conclusions about lines of communication in relation to operational reach.

The potential distance and duration, or operational reach, of Julius Caesar's legions depended on locally obtained and transported support, which hindered the army's operations.

---

<sup>129</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*, 8–10.

<sup>130</sup> *Ibid.*, 13.

<sup>131</sup> Scheidel, Meeks, and Weiland, *ORBIS: The Stanford Geospatial Network Model of the Roman World*.

<sup>132</sup> Luttwak, *The Grand Strategy of the Roman Empire: From the First Century to the Third*, 13, 60, 67, 89, 125.



Caesar never had enough supplies to gain genuine operational endurance, but the nature of Roman tactics and the size of his force maintained the advantage of momentum in almost every battle his army fought in Gaul. This advantage in momentum, far beyond the supply lines of Narbonensis, actually may have caused the shortfall in endurance because of the distance the army was able to penetrate. Hence, we find Caesar stopping before every battle to negotiate with local tribes in order to feed his legionaries. The records of the Gallic Wars also note the critical importance of the temporary fortifications the legions constructed to protect themselves far from their provincial base.<sup>133</sup> What Caesar and his generals gained in momentum, they sacrificed in endurance and paid heavily for in terms of protection.

One hundred years later, the conditions had improved as Roman roads, built upon the pathways of pre-Roman Gaul, offered both protection and endurance to the forces moving toward the invasion of Britain. The size of these forces may have hindered their speed some but for the most part the introduction of road construction technology improved all three components of operational reach demonstrating the effectiveness that armies can gain through improved lines of communication.<sup>134</sup> Specifically, hard surface, all-weather roads organized for swift communication between major transportation hubs built alongside rivers that were central to the transportation of supplies increased the total volume and speed of Roman forces possible for deployment.<sup>135</sup> This emphasizes the role that infrastructure plays in an army's extension of operational reach.

The same infrastructure, along a series of fixed fortifications also supported the Germanic frontier. Along the frontier, the mixture of greatly increased endurance and protection combined

---

<sup>133</sup> Carlin A. Barton, "The Price of Peace in Ancient Rome," in *War and Peace in the Ancient World*, ed. Kurt A. Raaflaub (Malden, MA: Blackwell Publishing, 2007), 248. Barton illustrates that, though brave and unwilling to surrender, Julius Caesar's subordinate generals often found themselves far from the immediate aid of their fellow Romans.

<sup>134</sup> Von Hagen and Tomeucci, *The Roads that Led to Rome*, 211.

<sup>135</sup> Thompson, "Roman roads," 22.

with a strategically placed restraint on the army to greatly reduce the momentum of the force. It is difficult to evaluate the potential momentum of the legions along the frontier in comparison with the actual records of the limited use of momentum by that static force.<sup>136</sup> The history of the frontier indicates that the Romans could have employed a networked series of lines of communication that increased the protection and endurance of the force for significant momentum in response to raids, invasions, or rebellions. Admittedly, a question that remains unexplored is whether this static defense somehow limited the operational reach of later Roman forces during the periods preceding the fall of Rome in 476 AD.<sup>137</sup>

Whatever causes led to the later fall of the Roman empire, it is possible to comprehend from the three periods examined some of the nature of operational reach in Roman Gaul. The Gallic roads were enough for the initial conquest, but Caesar utilized his forces to construct additional causeways and bridges for specific tactical purposes. Shortly after Rome consolidated the province as a formal part of the empire, the Romans began frequent, yet intermittent, construction and improvement of Gallic trails into true Roman roads. These roads, and the fortifications that the Romans used to secure them, were vital to the successful conquest of Britain. Likewise, from the conquest of Gaul until the fall of the empire, the roads, in whatever condition, supported the frontier both externally and amongst the forces that Rome had stationed there.

The accounts of the Roman use of Gallic roads and subsequent construction of Roman roads in Gaul to support the operational reach of the Roman Army form exemplary cases for

---

<sup>136</sup> Syme, "Rhine and Danube Legions under Domitian," 41–43. Syme's account shows the static and garrisoned nature of the legions along the Rhine while Danube regions faced more active enemies. Harald Von Petrikovits, "Fortifications in the North-Western Roman Empire from the Third to the Fifth Centuries," *The Journal of Roman Studies* 61 (1971): 192–193. The changes in fortifications support the changes in the temperament of the legions.

<sup>137</sup> O'Brien, *Atlas of World History*, 56–57. An interesting starting point for such an investigation would be to compare the routes of Rome's invaders with the existing Roman roads.

examining the nature of operational reach. The evolution of operational reach available to Rome grew with the roads and other lines of communication of the empire. Likewise, as the cities and ports along the roads began flourishing, they served to extend operational reach as centers of supply. When granaries that supported the public courier grew to support traveling army units, operational reach through basing opportunities again increased. Lines of communication and basing extended the potential reach of Rome even when that reach manifested itself primarily in the forms of endurance and protection rather than through the momentum of conquest.

In a similar manner, any army can seek to increase its operational reach and further distance itself from the point of culmination through the establishment of forward basing and improvement of relevant lines of communication. Roads were the primary lines of communication for the legions, as were the rivers for their supply lines. In a modern army, the lines of communication might be by sea, air, rail, or remain road-bound. It is even possible to conceive of cyber lines of communication. No matter what form they take, improvements to lines of communication and basing will improve the potential operational reach available to the commander.

This affirms the relationship of basing and lines of communication to operational reach. The subordinate elements of momentum, endurance, and protection are also critical to a fully formed understanding of these concepts. By increasing the momentum of their force, unless through a technological improvement such as enhanced lines of communication, commanders risk reducing either the endurance or protection afforded to their forces as they near the culminating point. Endurance functions in a similar manner. A force that dedicates a significant amount of resources to increased endurance will carry with it such a tail that it will become more difficult to maintain momentum and force protection costs will increase. Increasing protection to increase operational reach is very likely to decrease the momentum of the protected force. The example of the Germanic frontier shows that this trade is most likely in a defensive position, possibly due to an external cause such as a strategic boundary.

Even when strategic considerations established the borders of the empire, operational reach determined the boundaries of the legions. Before Tiberius chose to enforce Augustus' dictated strategic boundary along the Rhine River in 16 AD, Germanicus' multiple unsuccessful excursions into Germania began to establish both a physical and temporal boundary of their own. When Caesar crossed the Rhine and returned two years in a row, it was not because Caesar did not love conquest. Germania did not offer the same lines of communication to the legions that would support them in a conquest as those in Gaul. When Publius Quinctilius Varus and his three legions died at the hands of Arminius, they were in the process of cutting a trail through the Teutoberg forest. The constrained access to extant and functioning lines of communication established the physical boundary of Rome.

In Caesar's conquest, the temporal boundary forced upon a commander by operational reach is visible through his constant need to find grain to feed the army. Caesar had to stop frequently to secure food for his army and more nightly to construct marching camps for their protection. This established a set period of time that the army could expect to operate, whether or not Caesar and his generals thought of it in these modern terms.

Physical boundaries are easy enough to define on modern battlefields and in current U.S. Army doctrine.<sup>138</sup> Temporal boundaries manifest themselves in the form of phases and transitions. The distance and duration a force is able to operate according to operational reach influences both these forms of boundaries. Commanders and staffs who wish to ensure that their forces are able to operate at their maximum potential without reaching a culmination point need to understand the interplay between physical boundaries, phases, and operational reach.

Through a thorough examination of the battlefield factors that influence operational reach on the positive side and culmination from the opposite perspective, commanders and staffs can

---

<sup>138</sup> United States, *Field Manual 1-02: Operational Terms and Graphics*.

determine the appropriate placement of physical boundaries and phase transitions during operational planning. Technology plays a more ubiquitous role today than it did in antiquity but the techniques used to construct all-weather roads were a technological advancement. Improved lines of communication are a proven factor that increases potential operational reach. Additionally, basing can extend or at least advance the operational reach of the force. These factors of technology, lines of communication, and basing are the first set of data required to understand a force's potential operational reach.

The observable correlation between the three components of operational reach also aids the commander and his staff in developing a complete understanding of how to apply battlefield factors to improve operational reach. Although improvements to technology, lines of communication, and basing will increase all three, if those factors remain constant, there is interplay between endurance, momentum, and protection that will require acceptable sacrifice in some areas in order to increase in others. Increases in momentum are likely to result in a reduction to the potential of both endurance and protection. A priority placed on endurance will reduce the immediate momentum the force can exert through such concepts as force surges. Intensification of protection also reduces the momentum of the force and may reduce the endurance as well, depending on how commanders decide to execute it.

The Roman roads in Gaul served the empire well in maintaining that bountiful province. They have also served well to illustrate the nature of operational reach. Just like Rome was able to use a complex network of roads instead of massive forces to maintain the security of a vast empire, the United States and its allies face problems like anti-access and area denial by enemy forces with a view to increased operational reach. Technology, lines of communication, and

forward basing paired with a deliberate use of momentum, endurance, and protection will greatly increase the success of the U.S. Army against such challenges.<sup>139</sup>

---

<sup>139</sup> Any study such as this one raises more questions than it answers. Some of the more stimulating counterfactuals and points of interest this study brings to mind might be worth further research. With regard to the early conquest, historians could ask the question, would Caesar's conquest of Gaul have occurred in a shorter period of time or with less Roman casualties if he had been able to travel over Roman-style roads for his entire campaign? Would the pacification of Gaul have been important to Rome if the Via Julia Augusta did not require the security of Narbonensis? Additionally, did the Romans have the capacity to invade and conquer Britain without the Roman roads in Gaul? The first invasion by Caesar in 54 BC seems to indicate that Rome could not have taken Britain without the roads, but the question remains. These are only a selection of research possibilities that remain open.

## APPENDIX A: Mutual Support on the Rhine Frontier

It is difficult to understand the mutual support of the Roman frontier along the Rhine without examining the distances between the various fortified cities where Rome stationed the legions. While the cities of Germania Inferior were mutually supporting, the majority of the fortifications in Germania Superior were too far to receive support during the initial assault. Support from Narbonensis or Rome was weeks or months away so the legions stationed on the Rhine had to be partially self-sufficient. The table on the next page shows legionary deployments.

Distances in Roman miles										
	Arenacum		Noviomagus		Vetera		Novaesium		Cologne	
Noviomagus (Nijmegen, NL)	17									
Vetera (Xanten, GE)	42	35								
Novaesium (Neuss, GE)	80	68	42							
Agrippina (Cologne, GE)	105	96	67	26						
Bonna (Bonn, GE)	122	110	84	45	18					
Moguntiacum (Mainz, GE)	212	201	176	142	111	93				
Argentorate (Strasbourg, FR)	316	305	286	243	221	203	124			
Vindonissa (Windisch, SW)	420	408	390	350	325	307	227	105		
Narbonensis (Narbonne, FR)	790	776	763	727	704	694	668	553	505	
Roma (Rome, IT)	1195	1185	1167	1131	1110	1098	1072	950	907	706

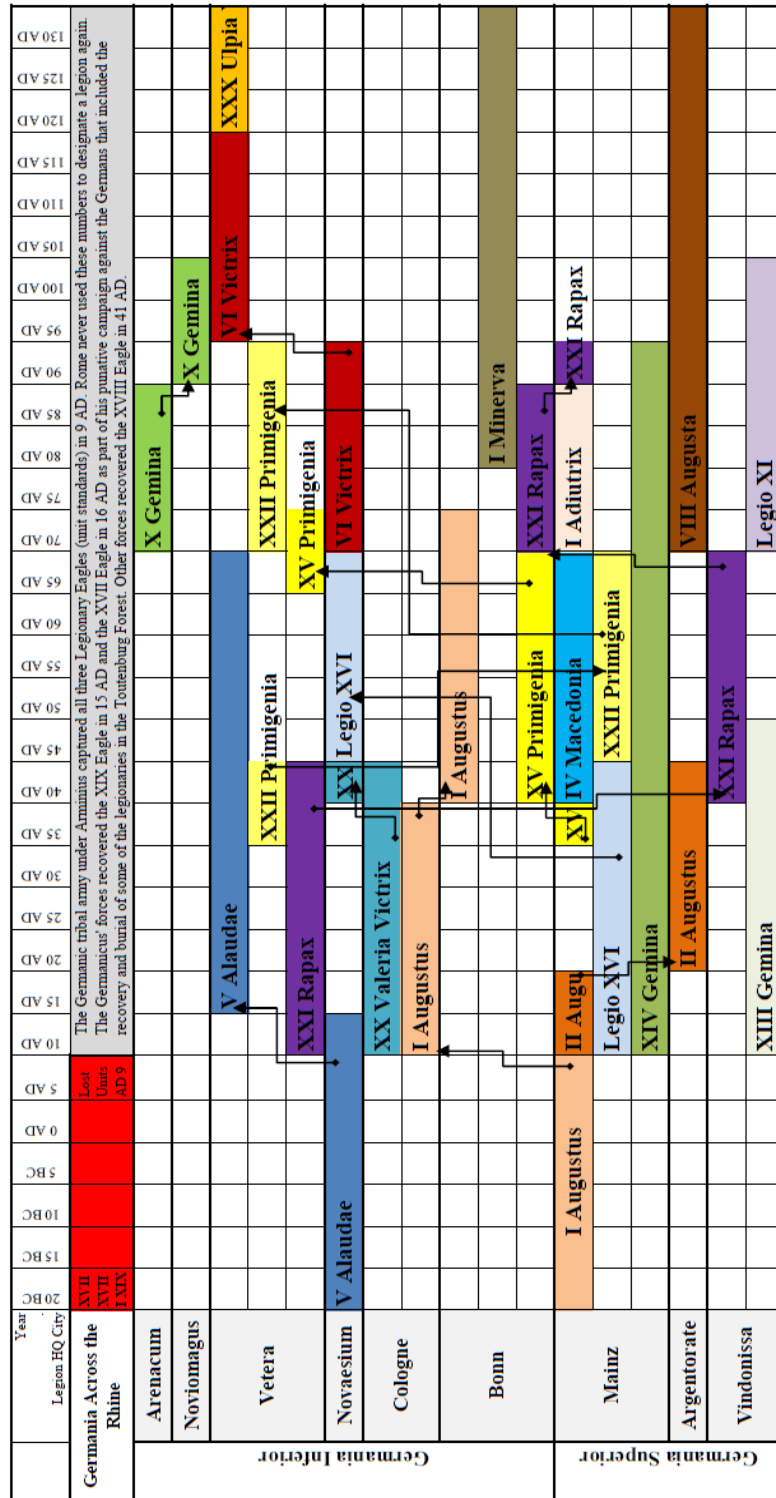
  

0-25	Relief in 24 hours
26-50	Relief in 2 days
51-75	Relief in 3 days
76-100	Relief in 4 days
101-125	Relief in 5 days
	Speed slows to 20 Roman miles/day
126-280	Relief in 2 weeks
281-600	Relief in 1 month
601-1200	Relief in 2 months

Distances between mutually supporting bases along the Rhine<sup>140</sup>

<sup>140</sup> Cornell and Matthews, *Atlas of the Roman World*, 129; “ORBIS.”

## The deployment of Roman legions stationed on the Rhine frontier<sup>141</sup>



<sup>141</sup> Developed from Hammond and Scullard, *The Oxford Classical Dictionary*, 591–593.



## APPENDIX B: The Cost of the Muscle & Animal Power of Rome

Today's military forces face a challenge in determining the fully burdened cost of supply items like fuel in austere environments.<sup>142</sup> The fully burdened cost of an item includes a calculation of the ancillary costs associated with transporting the item or material far from its point of manufacture. Fuel is the most noticeable of these costs since all delivery methods for fuel also consume fuel. The table below considers the fully burdened cost of fuel (or fodder, in most cases) that the Roman Army had to contend with in delivering supplies of grain and other goods to the frontier. The table displays multiple means of transportation and various beasts (including man) that could haul the necessary goods. The calculation at the end of the table – the fully burdened cost of fodder (FBCF) – attempts to determine the maximum and minimum possible distances a method of transport could go if it had to carry all of its own food.

Burdens over Distances						Consumption per Day (low/high)							
	Pack	Passenger	2-Wheel Cart	4-Wheel Wagon	Limitations	Grain (Oats, Barley, etc)	Hay / Green Fodder	Other Food	Water	Total	FBCF (best/worst)		
Mode													
Man	Load	36.2 kg	The bearing of liters or other conveyances does not qualify for the purpose of cargo			Min	.88 kg	N/A	.62 kg	.75 gal	1.5 kg	723 km	
	Dist	30-40 km				Max	unknown		varries	1.7 gal	-	965 km	
Mule	Load	114 kg	1 man	kg	kg	max trip	Min	1.5 kg	5 kg	No record of other foods required.	10 gal	6.5 kg	526 km
	Dist	30 km	30 km	30 km	30 km	2500 km	Max	4.5 kg	6 kg		unknown	10.5 kg	2500 km
Ox	Load	Loose skin makes oxen poor pack animals or mounts		kg	kg	100 km limit	Min	2.5 kg	6 kg	Treats	6 gal	8.5 kg	282 km
	Dist			14 km	14 km	/week	Max	7 kg	11 kg	(i.e. sugar, fruit, vegetables) not calculated.	7 gal	18 kg	1070 km
Horse	Load	70 kg	1 man	272 kg	454 kg	1 day rest /5-days work	Min	2.5 kg	4.5 kg		6 gal	7 kg	528 km
	Dist	80 km	30 km	80 km	80 km		Max	3.6 kg	7 kg		12 gal	10.6 kg	2500 km

### The fully burdened cost of fodder (FBCF)<sup>143</sup>

<sup>142</sup> Pierre Belanger and Alexander Scott Arroyo, "Logistics Islands: The Global Supply Archipelago and the Topologies of Defense," *Prisim: A Journal of the Center for Complex Operations* vol. 3, no. 4 (2012): 65–67.

<sup>143</sup> Marcy, *The Prairie Traveler: A Handbook for Overland Expeditions*; Wolseley, *The Soldier's Pocket-Book for Field Service*; Lt Carre, *Tentage and Equipage Series Report No. 8: Historical Review of the Load of the Foot Soldier*, trans. P. L. Milies (Washington, DC, 1908);

The limitations of each means of conveyance tell a lot about the capabilities of any system that travels on muscle-power alone. When calculating the range of each conveyance one should consider possible cargo of various boats and vessels that traveled the rivers and seas near Rome's roads as well as the availability of a sufficient supply locally. For example, riverboats often carried the equivalent of 100 mule-loads of olive oil to within pack-animal range.<sup>144</sup> Archaeological evidence, believed to be from the third century AD, exists indicating that barley was locally procured in Britain rather than the Romans shipping in Gallic wheat to feed the legions.<sup>145</sup>

The data for this table comes from multiple sources with calculations converted to kilometers and kilograms for the sake of the potential end user. To convert kilometers into Roman miles, multiply the quantity in kilometers by 0.675. A Roman mile is 0.92 statute miles. This table is in kilometers in hopes of immediate usability if military planners are ever seeking numbers to estimate the future use of beasts of burden in austere environments.

---

Teague, *Gettysburg by the Numbers: The Essential Pocket Compendium of Crucial and Curious Data about the Battle*; Goldsworthy, *The Roman Army at War: 100 B.C. - A.D. 200*, Appendix A.

<sup>144</sup> Casson, *Travel in the Ancient World*, 65.

<sup>145</sup> Britton and Huntley, "New evidence for the consumption of barley at Romano-British military and civilian sites, from the analysis of cereal bran fragments in faecal material."

## BIBLIOGRAPHY

- Ashby, T., and R.A.L. Fell. "The Via Flaminia." *The Journal of Roman Studies* 11 (1921): 125–190.
- Barton, Carlin A. "The Price of Peace in Ancient Rome." In *War and Peace in the Ancient World*, edited by Kurt A. Raaflaub, 245–255. Malden, MA: Blackwell Publishing, 2007.
- Belanger, Pierre, and Alexander Scott Arroyo. "Logistics Islands: The Global Supply Archipelago and the Topologies of Defense." *Prisim: A Journal of the Center for Complex Operations* vol. 3, no. 4 (2012): 55–75.
- Britton, Kate, and Jacqui Huntley. "New evidence for the consumption of barley at Romano-British military and civilian sites, from the analysis of cereal bran fragments in faecal material." *Vegetation History and Archaeobotany* 20, no. 1 (2011): 41–52.  
<http://www.springerlink.com/index/10.1007/s00334-010-0245-3>.
- Brodersen, Kai. "The Presentation of Geographical Knowledge for Travel and Transport in the Roman World: Itineraria non tantum adnotata sed etiam picta." In *Travel and Geography in the Roman Empire*, edited by Colin Adams and Ray Laurence. London: Routledge, 2001.
- Brogan, Olwen. "Trade between the Roman Empire and the Free Germans." *The Journal of Roman Studies* 26 (1936): 195–222.
- Bruce, F.F. *The Canon of the Scripture*. Downers Grove, IL: InterVarsity Press, 1988.
- Burns, Thomas S. *Rome and the Barbarians: 100 B.C.-A.D. 400*. Baltimore: The Johns Hopkins University Press, 2003.
- Caesar, Julius. *The Complete Works of Julius Caesar*. Translated by W.A. McDevitte and W.S. Bohn. Kindle ed. Amazon.com: Kindle Public Domain Books, n.d.
- Campbell, Brian. "Shaping the Rural Environment : Surveyors in Ancient Rome." *The Journal of Roman Studies* 86 (1996): 74–99.
- . *The Roman Army, 31 BC-AD 337: A Sourcebook*. London: Routledge, 1994.
- . "Who Were the 'Viri Militares?'" *The Journal of Roman Studies* 65 (1975): 11–31.
- Carre, Lt. *Tentage and Equipage Series Report No. 8: Historical Review of the Load of the Foot Soldier*. Translated by P. L. Milies. Washington, DC, 1908.
- Casson, Lionel. *Travel in the Ancient World*. Baltimore: The Johns Hopkins University Press, 1994.
- Charlesworth, M.P. *Trade-Routes and Commerce of the Roman Empire*. 2nd ed. Cambridge: Cambridge University Press, 1926.
- Cheesman, G.L. *The Auxilia of the Roman Imperial Army*. Chicago: Ares Publishers, 1914.

- Chevallier, Raymond. *Roman Roads*. Translated by N.H. Field. Berkeley: University of California Press, 1976.
- Clausewitz, Carl Von. *On War*. Translated by Michael Howard and Peter Paret. Princeton: Princeton University Press, 1976.
- Corcoran, Simon, ed. *Codex Theodosianus: Le code Théodosien V*. Translated by S. Petrequez-Crogiin, P. Jaillette, and J.M. Poinssotte. Vol. 5. Brepols Publishers, 2009.
- Cornell, Tim, and John Matthews. *Atlas of the Roman World*. Edited by Graham Speake, Andrew Lawson, Liz Orrock, Zoe Goodwin, and Jennifer Drake-Brockman. New York: Facts on File, 1982.
- Crawford, O.G.S. "A Note on the Peutinger Table and the Fifth and Ninth Iters." *The Journal of Roman Studies* 14 (1924): 137–141.
- Crone, G.R. "The Site and Growth of Paris." *The Geographical Journal* 98, no. 1 (1941): 35–47.
- Dando-Collins, Stephen. "Caesar's Legion: The Epic Saga of Julius Caesar's Elite Tenth Legion and the Armies of Rome". Ashland, OR: Blackstone Audio, 2005.
- Drinkwater, J.F. "For Better or Worse? Towards an Assesment of the Economic and Social Consequences of the Roman Conquest of Gaul." In *The Early Roman Empire in the West*, edited by Thomas Blagg and Martin Millett, 210–219. Oxford: Oxbow Books, 2002.
- Dyson, Stephen L. *The Creation of the Roman Frontier*. Princeton: Princeton University Press, 1985.
- Erdkamp, Paul. *A Companion to the Roman Army*. Malden, MA; Oxford: Blackwell, 2007.
- Fabricus, Ernst. "Some Notes on Polybius's Discription of Roman Camps." *The Journal of Roman Studies* 22, no. Part 1 (1932): 78–87.
- Forbes, Henry O. "The Topography of Cæsar's Last Campaign against the Bellovaci." *The Geographical Journal* 59, no. 3 (1922): 195–206.
- Garnsey, Peter, Tom Gallant, and Dominic Rathbone. "Thessaly and the Grain Supply of Rome during the Second Century B. C." *The Journal of Roman Studies* 74 (1984): 30–44.
- Gilliver, Kate, Adrian Keith Goldsworthy, and Michael Whitby. *Rome at War: Caesar and His Legacy*. Oxford: Osprey Publishing Limited, 2005.
- Goldsworthy, Adrian Keith. *In The Name of Rome: The Men Who Won the Empire*. London: Orion Books, 2003.
- . "Roman Warfare." *NYMAS Friday Evening Talk*, 2013.  
<http://nymas.org/podcasts/AdrianGoldsworthy-RomanWarfare160kbps.mp3> (accessed July 4, 2013).

- . *The Roman Army at War: 100 B.C. - A.D. 200*. Oxford: Oxford University Press, 1996.
- Von Hagen, Victor W., and Adolfo Tomeucci. *The Roads that Led to Rome*. Cleveland, OH: The World Publishing Company, 1967.
- Hammond, N.G.L., and H.H. Scullard, eds. *The Oxford Classical Dictionary*. 2nd ed. Oxford: Oxford University Press, 1970.
- Isaac, Benjamin. "The Meaning of the Terms Limes and Limitanei." *The Journal of Roman Studies* 78 (1988): 125–147.
- Josephus, Flavius. *The Works of Josephus: New Updated Version Complete and Unabridged in One Volume*. Translated by William Whitson. Peabody, MA: Hendrickson Publishers, 1987.
- Justinian. *The Digest of Justinian*. Translated by Alan Watson. Vol. 4. Philadelphia: University of Pennsylvania Press, 1985.
- Kunow, Jurgen. "Relations between Roman occupation and the Limesvorland in the province of Germania Inferior." In *The Early Roman Empire in the West*, edited by Thomas Blagg and Martin Millett, 87–96. Oxford: Oxbow Books, 2002.
- Leslie, Alan F. "Roman temporary camps in Britain." *Corpus*, 1995. <http://theses.gla.ac.uk/789/>.
- Livius, Titus (Livy). *The History of Rome: In Three Volumes*. Translated by D. Spillan. Unexpurgat. Amazon.com: Halcyon Classics, n.d.
- Luttwak, Edward N. *The Grand Strategy of the Roman Empire: From the First Century to the Third*. Baltimore: The Johns Hopkins University Press, 1976.
- Marcy, Randolph B. *The Prairie Traveler: A Handbook for Overland Expeditions*. Washington, DC: Authority of the War Department, 1859.
- Matyszak, Philip. *Legionary: The Roman Soldier's (Unofficial) Manual*. London: Thames & Hudson LTD, 2009.
- Mitchell, Stephen. "Requisitioned Transport in the Roman Empire : A New Inscription from Pisidia." *The Journal of Roman Studies* 66 (1976): 106–131.
- O'Brien, Patrick, ed. *Atlas of World History*. 2nd ed. New York: Oxford University Press, 2002.
- Odierno, Raymond T., and John M. McHugh. *Army Strategic Planning Guidance 2013*. Washington, DC, 2013.
- Petrikovits, Harald Von. "Fortifications in the North-Western Roman Empire from the Third to the Fifth Centuries." *The Journal of Roman Studies* 61 (1971): 178–218.
- Plutarch. *Plutarch: Lives of the noble Grecians and Romans*. Kindle ed. Amazon.com: Kindle Public Domain Books, n.d.

- Polybius. *The Complete Histories of Polybius*. Translated by W.R. Paton. Kindle ed. Digireads.com Publishing, 2010.
- . *The Rise of the Roman Empire*. Translated by Ian Scott-Kilvert. London: Penguin Books LTD, 1979.
- Purcell, Nicholas. “The Creation of Provincial Landscape: the Roman Impact on Cisalpine Gaul.” In *The Early Roman Empire in the West*, edited by Thomas Blagg and Martin Millett, 7–29. Oxford: Oxbow Books, 2002.
- Quick, R., and Stephen J. Simon. “Wheat production and the Romanization of northern Gaul.” *The Ancient world* 30, no. 1 (1999): 59–62.
- Ramsay, A.M. “The Speed of the Roman Imperial Post.” *The Journal of Roman Studies* 15 (1925): 60–74.
- Renatus, Flavius Vegetius (Vegetius). *Military Institutions of the Romans*. Edited by Thomas R. Phillips. Translated by John Clark. Harrisburg, PA: Stackpole Books, 1944.
- Richmond, I.A. “Notes on the History of Ancient Roads and Their Construction by R. J. Forbes Review.” *The Journal of Roman Studies* 25 (1935): 113–114.
- Roth, Jonathan. *The Logistics of the Roman Army in the Jewish War*. Ann Arbor, MI: UMI Dissertation Services, 1991.
- Scheidel, Walter. “Princeton/Stanford Working Papers in Classics: The Shape of the Roman World”. Stanford, 2013.
- Scheidel, Walter, Elijah Meeks, and Jonathan Weiland. *ORBIS : The Stanford Geospatial Network Model of the Roman World*, 2012.
- Schonberger, H. “The Roman Frontier in Germany : An Archaeological Survey.” *The Journal of Roman Studies* 59, no. 1/2 (1969): 144–197.
- Scullard, H.H. *From Gracchi to Nero: A History of Rome from 113 B.C. to A.D. 68*. 5th ed. London: Routledge, 1982.
- Sherwin-White, A.N. “The Tabula of Banasa and the Constitutio Antoniniana.” *The Journal of Roman Studies* 63 (1973): 86–98.
- Straker, Ernest, and Ivan D. Margary. “Ironworks and Communications in the Weald in Roman Times.” *The Geographical Journal* 92, no. 1 (1938): 55–60.
- Syme, Ronald. “Rhine and Danube Legions under Domitian.” *The Journal of Roman Studies* 18 (1928): 41–55.
- Tacitus. *The Complete Tacitus Anthology*. Kindle ed. Bybliotech.org, 2012.
- Talbert, J.A., ed. *Atlas of Classical History*. New York: Macmillan Publishing Company, 1985.

- Teague, Charles. *Gettysburg by the Numbers: The Essential Pocket Compendium of Crucial and Curious Data about the Battle*. Gettysburg, PA: Adams County Historical Society, 2006.
- Thompson, Logan. "Roman roads." *History Today* 47, no. 2 (1997): 21–28.
- Thrower, Norman J.W. *Maps & Civilization: Cartography in Culture and Society*. Second ed. Chicago: University of Chicago Press, 1999.
- Tranquillus, Gaius Suetonius (Suetonius). *The Twelve Caesars*. Edited by T. Forester. Translated by Alexander Thomson. Kindle ed., n.d.
- United States, Department of the Army. *Army Doctrine Publication 4-0: Sustainment*. Washington, DC: Headquarters, Department of the Army, 2012.
- . *Army Doctrine Reference Publication 3-0: Unified Land Operations*. Washington, DC: Headquarters, Department of the Army, 2012.
- . *Army Doctrine Reference Publication 4-0: Sustainment*. Washington, DC: Headquarters, Department of the Army, 2012.
- . *Army Doctrine Reference Publication 5-0: The Operations Process*. Washington, DC: Headquarters, Department of the Army, 2012.
- . *Field Manual 1-02: Operational Terms and Graphics*. Washington, DC: Headquarters, Department of the Army, 2004.
- United States, Joint Chiefs of Staff. *Joint Publication 4-0: Joint Logistics*. Washington, DC: Department of Defence, 2008.
- Vicente González, José Luis. "GIS and roman ways research in hispania." In *ESRI European User Conference 2011*, 23, 2011.  
<http://evento.esri.es/es/euc/agenda/ponencia/investigacion-de-la-red-viaria-romana-de-hispania-mediante-tecnologias-sig-gis-and-roman-ways-research-in-hispania/>.
- Ward Perkins, J.B. "Etruscan and Roman Roads in Southern Etruria." *The Journal of Roman Studies* 47, no. 1 (1957): 139–143.
- Wheeler, R.E.M. "The Roman Town-Walls of Arles: and a Note on Other Roman Town-Walls in Gaul and Britain." *The Journal of Roman Studies* 16 (1926): 174–193.
- Wolseley, Garnet J. *The Soldier's Pocket-Book for Field Service*. 2nd ed. London: Macmillan and Co., 1871.
- "National Geographic 1: 8,425,000 Scale Map of Europe". Washington, D.C.: National Geographic Maps, 2011.
- "ORBIS", n.d. <http://orbis.stanford.edu/#mapping> (accessed September 27, 2013).