Continental United States (CONUS) Interceptor Site

APPENDICES

Environmental Impact Statement
Draft

Department of Defense
Missile Defense Agency
5700 18th Street
For Belvoir, VA 22060-557

May 2016

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APPENDIX A

ACRONYMS AND ABBREVIATIONS

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Acronyms and Abbreviations

^{0}F	degrees Fahrenheit
2,4-DNT	2,4-dinitrotoluene
A&LF	administrative and logistics facility
A.D.	anno Domini
AADT	Annual Average Daily Traffic
ACAM	Air Conformity Applicability Model
ac-ft/yr	acre-feet per year
ACHP	Advisory Council on Historic Preservation
ACM	asbestos containing material
ACUB	Army Compatible Use Buffer
AGL	above ground level
AHU	air-handling unit
AIRFA	American Indian Religious Freedom Act
AL	aluminum powder
AMATS	Akron Metropolitan Area Transportation Study
AMC	Army Materiel Command
AMEC	AMEC Earth & Environmental, Inc.
AMEC E&I	AMEC Environment & Infrastructure, Inc.
ANGB	Air National Guard Base
AOC	area of concern
AP	ammonium perchlorate
APE	Area of Potential Effects
AR	Army Regulation
ARNG	Army National Guard
ARPA	Archaeological Resources Protection Act of 1979
AST	aboveground storage tank
ATC	Air Traffic Control
ATV	all-terrain vehicle
AUID	assessment unit identification number
B.C.	before Christ
B.P.	before present
BACT	Best Available Control Technology
BEA	U.S. Bureau of Economic Analysis
BGEPA	Bald and Golden Eagle Protection Act of 1940
bgs	below ground surface
BL	Business Loop
BMDO	Ballistic Missile Defense Organization
BMDS	Ballistic Missile Defense System

BMP	Best Management Practices
BTL	W.K. Kellogg Airport
CAA	Clean Air Act
CCRG	Commonwealth Cultural Resources Group, Inc.
CEMED	Cease Maintenance, Excess, and Dispose of Select Buildings
Census	U.S. Census Bureau
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHA	Community Health Assessment
CIS	CONUS Interceptor Site
CO	carbon monoxide
CO_2e	carbon dioxide equivalent
COC	contaminant of concern
CONUS	Continental United States
CRJMTC	Camp Ravenna Joint Military Training Center
CWA	Clean Water Act
CY	cubic yards
DANC	Development Authority of the North Country
dB	decibel; unit of sound level referenced to 20 micropascals
dBA	A-weighted decibel; also referenced to 20 μPa
DHV	Design Hour Volume
DOD	Department of Defense
DOI	Department of Interior
DoT	U.S. Department of Transportation
EA	Environmental Assessment
EB	eastbound
ECF	entry control facility
EIS	Environmental Impact Statement
EISA	Energy Independence and Security Act
EMA	Emergency Management Association
EME	electromagnetic environment
EMO	Emergency Management Office
EMR	electromagnetic radiation
ENS	Environmental Noise Survey
EO	Executive Order
EOP	Eastern Ontario Plains
EPCRA	Emergency Planning and Community Right-to-Know Act
ESA	Endangered Species Act of 1973, as amended

ESQD	Explosive Safety Quantity-Distance
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FCRA	Fort Custer Recreation Area
FCTC	Fort Custer Training Center
FDRLO	FTD Regional Liaison Organization
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FHWA	Federal Highway Administration
FLPMA	Federal Land Policy and Management Act
FOC	Fiber Optic Communication
FONPA	Finding of No Practicable Alternative
FR	Federal Register
ft	foot or feet
FTD	Fort Drum
FWCA	Fish and Wildlife Conservation Act of 1980, as amended
FY	Fiscal Year
GACT	Generally Available Control Technologies
GBI	Ground-Based Interceptor
GFC	GMD Fire Control
GHG	greenhouse gas
GHz	gigahertz
GIS	Geographic Information System
GMD	Ground-Based Midcourse Defense
GPCD	gallons per capita per day
gpm	gallons per minute
GS&FCS	Ground Support & Fire Control Systems
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HAP	hazardous air pollutant
HazCom	Hazard Communication Standards
HazMat	hazardous material
HazWst	Hazardous Materials and Waste
HCS	Highway Capacity Software
HMCP	Hazardous Materials Control Point
HMWMP	Hazardous Materials and Waste Management Plan
HUC	Hydrologic Unit Code
HTPB	hydroxyl-terminated polybutadiene
HWMP	Hazardous Waste Management Plan
Hz	hertz (unit of frequency)

I	Interstate
IBD	Inhabited Building Distance
IBI	Index of Biological Integrity, scoring metrics for stream quality
ICBM	intercontinental ballistic missile
IBV	integrated boost vehicle
ICP	Integrated Contingency Plan
ICRMP	Integrated Cultural Resources Management Plan
IDLH	Immediately Dangerous to Life or Health
IDT	In-Flight Interceptor Communications System Data Terminals
IFICS	In-Flight Interceptor Communications System
IFR	Instrument Flight Rules
ILFP	In-Lieu Fee Program
IMPLAN	Impact Analysis for Planning
IN	Indiana
INDoT	Indiana Department of Transportation
INRMP	Integrated Natural Resources Management Plan
IONMP	Installation Operational Noise Management Plan
IPaC	Information, Planning, and Conservation, a FWS website to aid project decisions
IRP	Installation Restoration Program
ISF	Interceptor Storage Facility
ISFAC	IDT Support Facility
JD	Jurisdictional Determination (of wetlands)
JHA	Job Hazard Analysis
KNC	Kalamazoo Nature Center
KOP	Key Observation Point
KV	kill vehicle
kW	kilowatts
L_{dn}	day-night average sound level
L_{eq}	equivalent continuous sound level
L_x	sound level exceeded X percent of time
L&A	Lawhon & Associates, Inc.
LAER	Lowest Achievable Emission Rate
LBP	lead-based paint
LE/MC	launch essential/mission critical
LED	light-emitting diode
LHZ	launch hazard zone
LOS	Level of Service
LRC	Long Range Component of Range Complex Master Plan
M	Michigan State Route

MAB	missile assembly building
MACT	Maximum Achievable Control Technology
MAGLC	maximum acceptable ground level concentration
MBTA	Migratory Bird Treaty Act of 1918
MBtu/hr	million British thermal units per hour
MCL	Maximum Contaminant Level
MCOC	munitions constituent of concern
MCY	million cubic yards
MDA	Missile Defense Agency
MDC	Missile Defense Complex
MDEQ	Michigan Department of Environmental Quality
MDMVA	Michigan Department of Military and Veterans Affairs
MDNR	Michigan Department of Natural Resources
MDOT	Michigan Department of Transportation
MEB	mechanical/electrical building
MEC	munitions and explosives of concern
mg/kg	milligram per kilogram
mg/L	milligram per liter
MGD	million gallons per day
MHz	megahertz
MI	Michigan
mi^2	square miles
MILCON	Military Construction
MIRIS	Michigan Resource Inventory System
mm	millimeter
MMPA	Marine Mammal Protection Act of 1972, as amended
mph	miles per hour
MNFI	Michigan Natural Features Inventory
MOVES	Motor Vehicle Emission Simulator
MRS	Munitions Response Site
m/sec	meters per second
MSF	maintenance support facility
MSG	Mannik & Smith Group, Inc.
MSL	mean sea level
MV	Medivac
MW	megawatt
MWH	MWH Americas, Inc.
MWR	Morale, Welfare, and Recreation
NA NSR	Nonattainment New Source Review
NAAQS	National Ambient Air Quality Standards

NAGPRA	Native American Graves Protection and Repatriation Act
NATA	National-Scale Air Toxics Assessment
NB	Northbound
NBC	nuclear, biological, and chemical
NDAA	National Defense Authorization Act
NEI	National Emission Inventory
NEPA	National Environmental Policy Act
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act of 1966, as amended
NLEB	Northern long-eared bat
NMFS	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NML	Noise Measurement Location
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOTAM	Notice to All Airmen Message Service
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NREPA	Michigan Natural Resources and Environmental Protection Act 451 of 1994
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NSR	New Source Review
NWI	National Wetlands Inventory
NY	New York
NYCRR	New York Codes, Rules, and Regulations
NYDOT	New York Department of Transportation
NYSDEC	New York State Department of Environmental Conservation
O_3	ozone
OAC	Ohio Administrative Code
ODH	Ohio Department of Health
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
ODS	Ohio Development Services
OEPA	Ohio Environmental Protection Agency
OH	Ohio
OHARNG	Ohio Army National Guard
OHPO	Ohio Historic Preservation Office
OHSSC	Oil and Hazardous Substance Spill and Contingency
ORAM	Ohio Rapid Assessment Method

Orbis	Orbis Environmental Consulting
ORC	Ohio Revised Code
OSHA	U.S. Occupational Safety and Health Administration/Act
OVA	Ohio Valley Archaeology, Inc.
PA	Programmatic Agreement
PAH	polycyclic aromatic hydrocarbon
PAL	Project Action Limit
Pb	lead
PCB	polychlorinated biphenyl
PEA	Programmatic Environmental Assessment
PEL	Permissible Exposure Limit
PHF	peak hour factor
PHV	peak hour volume
PM	particulate matter
PM_{10}	particulate matter with diameters less than or equal to 10 microns
$PM_{2.5}$	particulate matter with diameters less than or equal to 2.5 micrometers
POV	Portage County Airport
PP	priority pollutant
PSD NSR	Prevention of Significant Deterioration New Source Review
PSI	Professional Services Industries, Inc.
PSS	Palustrine Scrub-Shrub
PTE	potential to emit
PTI	Permit to Install
PTIO	Permit to Install and Operate
PTR	public transit route
R&CF	readiness and communications facilities
RCMP	Range Complex Master Plan
RCRA	Resource Conservation and Recovery Act
RD	Road
RDP	Range Development Plan
RDX	cyclotrimethylenetrinitramine
RF	radio frequency
RHA	Rivers and Harbors Act
RICE	Reciprocating Internal Combustion Engines
RIMS II	Regional Input-Output Modeling System
ROI	Region of Influence
ROP	Renewable Operating Permit
ROW	right-of-way
RPMP	Real Property Master Plan
RSL	Risk Screening Level

RTI	Regional Training Institute
RTLP	Range and Training Land Development Program
RTLS	Ravenna Training and Logistics Site
Rule 57	Michigan Administrative Code, Part 4 Water Quality Standards, R323.1057 Toxic Substances Rule 57
RVAAP	Ravenna Army Ammunition Plant
SARA	Superfund Amendments and Reauthorization Act
SATCOM	satellite communication
SB	Southbound
SCF	security control facility
SCM	silo closure mechanism
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SDSFIE	Spatial Data for Facilities, Infrastructure, and Environment
SDZ	surface danger zone
SERE East	Center for Security Forces Detachment Kittery Survival, Evasion, Resistance, and Escape Facility
SHPO	State Historic Preservation Office/r
SIP	state implementation plan
SIV	silo interface vaults
SMDC	U.S. Space and Missile Defense Command
SO_2	sulfur dioxide
SOP	Standard Operating Procedure
SPCC	Spill Prevention, Control, and Countermeasures
SPEA	Supplemental Programmatic Environmental Assessment
sq. ft.	square feet/foot
SR	State Route
ssp.	several species
Stell	Stell Environmental Enterprises, Inc.
SVOC	semi-volatile organic compound
SWPPP	Stormwater Pollution Prevention Plan
TAC	Toxic Air Contaminant
T-BACT	toxics best available control technology
TIS	Traffic Impact Study
TMDL	total maximum daily load
TNT	trinitrotoluene
tpy	tons per year
Tragus	Tragus Environmental Consultants, Inc.
TSS	Total Suspended Solids
U.S.	United States

UFC	Unified Facilities Criteria
μg/L	microgram per Liter
ULSFO	ultra-low sulfur fuel oil
USACE	U.S. Army Corps of Engineers
USC	United State Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USNORTHCOM	U.S. Northern Command
USPS	U.S. Postal Service
USSTRATCOM	U.S. Strategic Command
UST	underground storage tank
UXO	unexploded ordnance
VFR	Visual Flight Rules
VOC	volatile organic compound
vph	vehicles per hour
WAU	Watershed Assessment Unit
WB	Westbound
WMP	Watershed Management Plan
WOUS	waters of the United States
WWH	Warm Water Habitat

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APPENDIX B

NOTICE OF INTENT AND NOTICE OF AVAILABILITY

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prepare an environmental assessment or environmental impact statement.

Concurrent with the publication of this notice in the **Federal Register**, NMFS is forwarding copies of this application to the Marine Mammal Commission and its Committee of Scientific Advisors.

Dated: July 10, 2014.

Julia Harrison,

Acting Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. 2014–16666 Filed 7–15–14; 8:45 am]

BILLING CODE 3510–22–P

DEPARTMENT OF DEFENSE

Office of the Secretary

Notice of Intent To Prepare an Environmental Impact Statement (EIS) for the Continental United States Interceptor Site (CIS)

AGENCY: Missile Defense Agency, Department of Defense.

ACTION: Notice of intent.

SUMMARY: The Missile Defense Agency (MDA) announces its intention to prepare an Environmental Impact Statement (EIS) in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA. As required by the 2013 National Defense Authorization Act, the MDA has selected possible additional locations in the United States that would be best suited for future deployment of an interceptor capable of protecting the homeland against threats from nations, such as North Korea and Iran. The MDA is preparing this EIS to evaluate the potential environmental impacts that could result from the future deployment of the Continental United States Interceptor Site (CIS). The existing Ballistic Missile Defense System (BMDS) provides protection of the United States from a limited ballistic missile attack, and the Department of Defense has not made a decision to deploy or construct the CIS.

DATES: The MDA invites public comments on the scope of the CIS EIS during a 60-day public scoping period beginning with publication of this notice in the **Federal Register**. Comments will be accepted on or before September 15, 2014.

ADDRESSES: Written comments, statements, and/or concerns regarding the scope of the EIS or requests to be added to the EIS distribution list should be addressed to MDA CIS EIS and sent by email to *MDA.CIS.EIS@BV.COM*, by facsimile 913–458–1091, or by U.S. Postal Service to: Black & Veatch Special Projects Corp Attn: MDACIS EIS, 6601 College Boulevard, Overland Park, KS 66211–1504. Electronic or facsimile comments are preferred. If sending comments by U.S. Postal Service, please do not submit duplicate electronic or facsimile comments. All comments, including names and addresses, will be submitted to the administrative record.

FOR FURTHER INFORMATION CONTACT: Mr. Rick Lehner, MDA Public Affairs, at 571–231–8210, or by email: *mda.info@mda.mil.*

SUPPLEMENTARY INFORMATION: In accordance with 40 Code of Federal Regulations (CFR) 1501.6, an invitation for cooperating agency status has been extended to the U.S. Department of the Army and Navy and National Guard for consultation, review, and comment on the EIS. Other cooperating agencies may be identified during the scoping process.

If deployed, the CIS would be an extension of the existing Ground-based Midcourse Defense (GMD) element of the BMDS. Under the current proposed action, the deployment of the CIS would be as a contiguous Missile Defense Complex, similar to that found at Fort Greely, Alaska and would consist of an initial deployment of 20 Ground-based Interceptors (GBIs) with the ability to expand upward to 60 GBIs. The GBIs would not be fired from their deployment site except in the Nation's defense and no test firing would be conducted at the CIS. The overall system architecture and baseline requirements for a notional CIS include, but are not limited to, the GBI fields, Command Launch Equipment, In-Flight Interceptor Communication System Data Terminals, GMD Communication Network, supporting facilities, such as lodging and dining, recreation, warehouse and bulk storage, vehicle storage and maintenance, fire station, hazardous materials/waste storage, and roads and parking where necessary.

Alternatives to be analyzed include the No-Action Alternative and sites at the Combined Training Center Fort Custer—Michigan Army National Guard, Augusta, MI; Camp Ravenna Joint Military Training Center—Ohio Army National Guard, Portage and Trumbull Counties, OH; Fort Drum Army Base, Fort Drum, NY; and the Center for Security Forces Detachment Kittery Survival, Evasion, Resistance, and Escape Facility (SERE East), Redington Township, ME. At each site, impacts will be assessed for the following resource categories—air quality, air space, biological, cultural, geology and soils, hazardous materials and hazardous waste management, health and safety, land use, noise, socioeconomics, transportation, utilities, water quality, wetlands, visual and aesthetic, environmental justice, and subsistence.

The MDA encourages all interested members of the public, as well as federal, state, and local agencies to participate in the scoping process for the preparation of this EIS. The scoping process assists in determining the scope of issues to be addressed and helps identify significant environmental issues to be analyzed in depth in the EIS.

Scoping meetings will be held in the local communities of Ravenna, OH; Galesburg and Battle Creek, MI; Carthage, NY; and Rangeley and Farmington, ME, during July through September 2014. Notification of the meeting locations, dates, and times will be published and announced in local news media prior to public scoping meetings.

Dated: July 10, 2014.

Aaron Siegel,

Alternate OSD Federal Register Liaison Officer, Department of Defense.

[FR Doc. 2014–16629 Filed 7–15–14; 8:45 am]

BILLING CODE 5001–06–P

DEPARTMENT OF DEFENSE

Defense Acquisition Regulations System

[Docket Number DARS–2014–0030]

Information Collection Requirement; Defense Federal Acquisition Regulation Supplement (DFARS); Material Inspection and Receiving Report

AGENCY: Defense Acquisition Regulations System, Department of Defense (DoD).

ACTION: Notice and request for comments regarding a proposed extension of an approved information collection requirement.

SUMMARY: In compliance with section 3506(c)(2)(A) of the Paperwork Reduction Act of 1995 (44 U.S.C. chapter 35), DoD announces the proposed extension of a public information collection requirement and seeks public comment on the provisions thereof. *DoD invites comments on:* (a) Whether the proposed collection of information is necessary for the proper performance of the functions of DoD,

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APPENDIX C

SERE EAST – ALTERNATIVE CONSIDERED BUT NOT CARRIED FORWARD

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APPENDIX C

SERE East Site

Alternative Considered, but Not Carried Forward

C.1 Introduction

The Survival, Evasion, Resistance, and Escape Facility East (SERE East) alternative was initially assessed as a candidate location for potential deployment of a Continental United States (CONUS) Interceptor Site (CIS) but, in January 2016, was designated as an Alternative Considered but Not Carried Forward. Following completion of extensive surveys, conducted in coordination with federal and state agencies, the Missile Defense Agency (MDA) determined that the SERE East site was no longer a reasonable alternative because it presented irreversible environmental impacts, significant constructability concerns, and extensive costs associated with developing infrastructure in a remote area, and in January 2016, designated it as an Alternative Considered, but Not Carried Forward (MDA, 2016). A copy of the MDA Press Release is provided at the end of this Appendix. This section presents a summary description of the initially evaluated SERE East alternative.

C.1.1 SERE East Description

SERE East is located in northwestern Maine on approximately 12,466 acres in unincorporated Redington Township in Franklin County, Maine (Figure C.1-1). The training area is an undeveloped, forested river valley ringed with mountains. SERE East is comprised of two non-contiguous properties separated by the Appalachian National Scenic trail corridor. The primary mission of SERE East is wilderness survival training. Students include Navy aviators, aircrew, Special Forces personnel, force reconnaissance personnel, and others, including Marine Corps and Army personnel who, because of their duties, are most likely to be stranded behind enemy lines.

C.1.2 Potential CIS Deployment Layout at SERE East

As shown on Figure C.1-2, the CIS footprint at SERE East, would require up to 1,536 acres with an estimated 1,262 acres needing to be cleared. Due to this site's remote and previously undeveloped status, a larger area of 5,483 acres around the CIS footprint was included as part of the study area (primarily for field related studies).

As shown on Figure C.1-2, the SERE East potential CIS deployment consists of five separate areas including: Mission Area 1, Mission Area 2, two mission support areas, and a life support area. The mission areas could contain the facilities defined in Section 2.4 of the Environmental Impact Statement (EIS). However, due to the separation and distance between the two mission areas, a CIS, if deployed at SERE East, would require two separate power plants and associated fuel systems. The two mission support areas for a CIS at SERE East could contain the facilities defined in Section 2.4 of the EIS. A life support area was included for the potential CIS deployment at SERE East due to its remote location. It was assumed that non-mission facilities, such as the life support area, would be placed in the area indicated on Figure C.1-2; however no specific life support/non mission facilities were designated for a CIS. In addition to the life support area used during CIS operations, a temporary construction worker camp would be provided for construction of a CIS at SERE East.

Several facilities within the CIS footprint at SERE East were identified that would need to be relocated elsewhere on the installation. The area designated to relocate these facilities (e.g., 75 acres) is shown within the northeast area of the study area shown on Figure C.1-2.

Redington Road from the intersection of Highway 16 to the entrance of the SERE East site and to the CIS footprint would need to be upgraded as it is currently a dirt road.

For the SERE East potential deployment CIS, silo interface vaults (SIV)/silos would be transported, from a nearby port, over a road network capable of transporting the SIV/silos to the deployment site. If a deployment decision were made, the exact route would be coordinated with the state Department of Transportation (DOT) and could include interstate highways, state highways, and county roads. Preliminary discussions with the DOT have occurred to support this EIS analysis.

The nearest C-17 compatible airfield is in Bangor, ME, approximately 126 miles from the potential CIS. The C-17 would be required for equipment delivery to the CIS facilities.

C.2 Field Surveys and Studies Conducted for the SERE East Site

Field studies and surveys conducted to support the EIS at the SERE East site, in coordination with federal and state agencies, included infrastructure (including utilities), water resources, wetlands, transportation, and other resources for assessing the impacts of potential deployment for a CIS. The environmental studies and surveys conducted to support the analyses required for the EIS included the following, listed by resource:

- Biological Resources
  - Listed Species Survey Report prepared under contract to the Navy (E&E, 2015a).
  - Forestry Inventory Report prepared under contract to the Navy (Sewall, 2015).
- Cultural Resources
  - Cultural Resource Survey prepared under contract to the Navy (Stell, 2015a).
  - Tribal Cultural Affiliation Study prepared under contract to the Navy Study (Stell, 2015b).
  - Architectural Survey Report prepared under contract to the Navy (Stell, 2015c).

- Geology and Soils
    - CONUS Site Analysis Report (BVSPC, 2015).
    - Engineering evaluation to determine cut and fill requirements (no separate report was prepared).
- Noise
    - Noise Survey (results presented in Resource Evaluation in Appendix E-1, no separate report was prepared).
- Transportation
    - Heavy Haul: Transportation Study (MDA, 2015a).
- Wetlands
    - Wetlands Delineation Report prepared under contract to the Navy (E&E, 2015b).
- Visual/Aesthetics
    - Visual Survey (results presented in Resource Evaluation in Appendix E-1, no separate report was prepared).

C.3 Summary of Affected Environments and Impacts

Sixteen resources (air quality, airspace, biological, cultural, environmental justice, geology and soils, hazardous materials and hazardous wastes, health and safety, land use, noise, socioeconomics, transportation, utilities, water, wetlands, and visual/esthetics) were initially evaluated for the EIS. The evaluations are preliminary and were not completed because the work on evaluating the environmental impacts associated with potential deployment of a CIS at the SERE East site was halted when the site's status was changed to "Alternative Considered, but Not Carried Forward" (MDA, 2016).

Based on the results of the field studies and surveys, and the analysis conducted for the EIS, impacts to at least 7 of the 16 resources (biological resources, cultural resources, geology and soils, transportation, water resources, wetlands, and visual/esthetics) would be significant and irreversible if a decision was made to deploy and the SERE East Site was selected as the preferred alternative for a CIS. Given these anticipated impacts, the SERE East site presented significant constructability and schedule concerns and extensive costs associated with developing infrastructure in a remote area. A summary of the affected environment for these seven resources and the significant environmental impacts from construction and operation of the potential CIS at the SERE East site is provided in the following sections.

C.3.1 Geology and Soils

The terrain of the SERE East site is rugged, ranging from 1,440 feet to 3,760 feet above mean sea level (MSL). The mountain slopes typically have gradients of 15 to 30 percent ranging from occasional, nearly level benches to steep, almost vertical rock faces. The mountainous landscape is highly dissected by small, steep streams and tributaries.

Based on the results of the Site Analysis Report (BVSPC, 2015) and preliminary calculations of the cut and fill required (MDA, 2015b), there would be significant removal of soil and rock required at the SERE East site within the CIS footprint and minimal locations available to place the excess soil (fill). Based on the potential site layout shown on Figure C.1-2, a conservative estimate of the earthwork required would be approximately 150 to 300 million cubic yards (MCY) of material removed (cut) with only 1 to 5 MCY of fill needed (MDA, 2015b). The excess material would be required to be transported off-site for disposal. Blasting would be required to remove the significant amount of bedrock that would be encountered.

The required cut and fill at the SERE East site would result in major impacts to many environmental resources as discussed in the following sections.

C.3.2 Transportation

Transportation routes in the northern part of Maine's Lake and Mountain Region is comprised of a few state routes (SR); typically two-lane, narrow, hilly, and winding roads with limited right-of-ways (ROWs); to aid in the transportation of people and goods throughout the region. In the area around SERE East, SR 16 provides direct access to the installation and intersects with SRs 4, 17, and 27 within the Franklin County limits. While the preliminary assessment of the regional road network indicated that it could accommodate the CIS construction and operation personnel traffic, there would be a major impact to some regional roads due to the volume of truck traffic that would be required to transport the excess excavated material (soil and rock) to off-site locations.

The few existing on-site roads at SERE East are unpaved. Major road improvements would be required to meet pavement structural capacity, width, and geometric requirements to adequately facilitate vehicular transport of materials, equipment, and personnel to make the roads usable during construction and operation of a CIS.

The following assumptions were used to calculate the truck traffic required to haul the excess earthwork materials off-site during the construction:

- Earth disturbing activities would occur for 2 years.
- 20-cubic yard (CY) trucks would be used.
- A total spoil volume of 145 MCY to 295 MCY (net of cut minus fill volumes) would be hauled off-site.

- Shifts would be 10-hours per day, 6 days per week, averaging a 1-hour roundtrip from the CIS facility to off-site disposal location and back to CIS facility.

Based on these assumptions, a range of 2,325 to 4,730 trucks per hour would be required to remove the spoil volume from the CIS during construction. In terms of truck traffic, the amount of trucks on the road during any hour of the work day would be doubled since the trucks would be exiting and entering the site within the same 1-hour timeframe. This would result in a two-way truck volume of 4,650 to 9,460 trucks per hour. Because the maximum capacity of a two-lane highway under ideal conditions is 3,200 passenger vehicles per hour (not large trucks as would be needed to transport the significant amount of excess cut material) (TRB, 2010), the anticipated truck traffic would greatly exceed the capacity of the existing two-lane highway and would require the addition of travel lanes in each direction of traffic.

The following major impacts to transportation resources were identified from the potential construction of a CIS at the SERE East site:

- The majority of existing roads would need to be upgraded for on-site transportation of people, goods, and materials. Earthwork operations would have major impacts to the on-site roads and require constant daily maintenance during construction due to the tremendous number of trucks required to remove the excess soil.
- The capacity and structural integrity of the area roads that would be used to haul excess soil off-site would be exceeded and destroyed, respectively.
- Due to anticipated construction truck traffic, additional lanes would be required on the existing two-lane highways on routes used for the hauling of excess excavation materials off-site, and constant maintenance of pothole repair and resurfacing would be required which would also have major impacts, although not fully determined, on other resources.
- Once construction is completed, many miles of off-site roads would need to be reconstructed.

C.3.3 Biological Resources

The SERE East site is located in the Upper Montane/Alpine Zone and White Mountains/Blue Mountains Level III ecoregions within the Northeastern Highlands (Level IV ecoregion; Griffith et al., 2009). The Upper Montane/Alpine Zone ecoregion is characterized by glaciated rock peaks, high mountains with steep slopes and ridges, and high gradient headwater streams with boulders, cobbles, and bedrock substrates. Natural community types on the SERE East site property, based on an inventory conducted in the summer of 1999 (Tetra Tech, 2014b) indicated that approximately 97 percent of the land is forested. The remaining acreage (approximately 370 acres) was mapped as non-forested open area predominantly consisting of edge meadow, swamps, bogs and aquatic ecosystems, alpine zones, with relatively little developed area (Tetra Tech, 2014a). A broad array of wildlife species inhabits the SERE East site. According to data in the 2014 Integrated Natural Resources Management Plan (INRMP) (Tetra Tech, 2014a), 55 bird, 22 mammal, 14 herpetofauna, five fish, and six invertebrate species have been documented within the SERE East site. The Northern long-eared bat (*Myotis septentionalis*), a federally-listed threatened species under the Endangered Species Act, has been detected in acoustical surveys at SERE East (Tetra Tech, 2014b; E&E 2015b). While its presence has not been conclusively confirmed, its presence was characterized as probable during the 2015 acoustical survey (E&E, 2015b). Bicknell's Thrush (*Catharus bicknelli*) has been observed at SERE East; this species is currently under federal review for listing. The Black-crowned Night Heron (*Nycticorax nycticorax*) is the only state-listed species known to occur at SERE East. The Maine Department of Inland Fisheries and Wildlife has identified several types of significant wildlife habitat at SERE East, including high and moderate value waterfowl and wading bird habitat, shorebird feeding and staging areas, significant vernal pools, and deer wintering areas. Critical habitat for the endangered Atlantic salmon (*Salmo salar*) is present in the Oberton watershed which is partially located on SERE East. Six vernal pools were located during the wetland delineation survey, five of which were considered significant vernal pools based on the presence of vernal pool indicator species (i.e., Spotted or Blue Spotted Salamander eggs, fairy shrimp (E&E, 2015b).

CIS construction activities would adversely impact biological resources, primarily through conversion of natural habitats, primarily forest and wetlands, mainly a combination of forested and scrub-shrub wetlands, with significant forested areas to a heavily managed landscape lacking in vertical structure. Formerly forested areas would be drier, hotter and exposed to more sunlight, resulting in physical changes that would make the area unsuitable for many species. Soil exposed by vegetation removal would be more subject to erosion by wind and water, which may have additional impacts for vegetation remaining in nearby areas, such as settlement of suspended soil particles, burying plants. Due to vegetation removal and replacement by shallower-rooted plant species (mainly grasses replacing forbs, shrubs, and saplings or trees), precipitation would run off more readily, causing flows to accumulate in any drainages and potentially leading to flooding in areas not currently prone to overflows. Without appropriate stabilization, soil erosion could be significant, potentially causing sedimentation in streams that currently do not have heavy sediment loading and adversely affecting aquatic life, as well as obstructing or diverting stream flows.

The following is a summary of the major adverse impacts to biological resources identified from the potential construction of a CIS at the SERE East site:

- Loss of forested bat habitat.
- Wetland/stream/vernal pool fills resulting in habitat loss (direct impacts), and decreased water quality affecting aquatic organisms, mainly insects, salamanders and frogs, from erosion and sedimentation (indirect impacts).
- Wetland degradation or destruction from fill placement.

- Changes in hydrology would likely result in wetland degradation for wetlands not directly affected.
- Sedimentation loading in streams because of cleared vegetation, degrading water quality.
- Habitat conversion, potentially allowing non-native or invasive species to invade community.

C.3.4 Cultural Resources

For the SERE East site, the area of potential effects (APE) of the potential deployment of a CIS includes an approximately 1200-acre area which would be cleared as part of the project plus a 5-mile buffer zone around the CIS footprint. The 5-mile APE was established to include aspects of the visual impacts to cultural resources that might occur. As part of the EIS field surveys, an archaeological historic district was identified within the potential CIS footprint that included a village from the 1890s and a former railroad bed related to logging in the area was identified within the proposed CIS footprint (Stell, 2015a). This historic archaeological district was determined to be eligible for listing in the National Register of Historic Places (NRHP) (Stell, 2015a). Construction of a CIS at the SERE East site would destroy the portions of the historic district that fall within the CIS footprint resulting in a major impact to the cultural resources designated by this historic district.

The Appalachian National Scenic Trail, which has been determined to be eligible for listing on the NRHP is located immediately adjacent to the SERE installation and is currently undergoing actions to be listed in the NRHP (Stell, 2015a). There would be major impacts both visually and from noise to the Appalachian National Scenic Trail. The impacts to visuals/aesthetics are discussed in more detail in Section C.3.7. The impacts from noise would occur mainly during construction and would most likely include noise from blasting. In addition, portions of the Appalachian National Scenic Trail might require closing during certain phases of construction such as blasting for safety.

C.3.5 Water Resources

The SERE East site has several ponds, perennial and intermittent streams and tributaries, and numerous wetland areas. The largest pond, Redington Pond, is approximately 8 acres in size, was manmade in the 1890s or early 1900s (Stell, 2015a; Tetra Tech, 2014a), and is located east/adjacent to the CIS footprint. The two major streams draining the SERE East site are Redington and Orbeton streams; bisecting the SERE East site nearly in half in an east-west dissection, divided by a crest (1,674 feet elevation) located about 0.75 miles west of Redington Village. Areas to the east of this crest drain into Orbeton Stream, whereas those to the west drain into Redington Stream. (Tetra Tech, 2014a). Orbeton Stream originates near the installation's center within a wetland, then meanders east through a wetland along the valley floor until it reaches Redington Pond. Orbeton Stream continues south from Redington Pond in an easterly then southerly direction where it flows to the southeast border of the SERE East site, across the

Appalachian Trail right-of way, and continues across the southern parcel of the installation to its confluence with the Sandy River and eventually into the Kennebec River (Tetra Tech, 2014a). Redington Stream flows in a west-northwesterly direction from near the center of the site, paralleling Redington Stream Road. Redington Stream is a tributary of the South Branch of the Dead River and generally flows in a west-northwesterly direction from near the center of the site. The South Branch of the Dead River flows into Flagstaff Lake and eventually into the Kennebec River (Tetra Tech, 2014a).

Major affected environment features and impacts from construction of a CIS at the SERE East site were identified for water resources including the following:

- Surface Water/Streams:
  - 410 streams and 76 'other waters' including six vernal pools, four of these along Redington Stream Road. Approximately 20 acres in ponds and seeps.
  - 174 stream-miles on the site, including constructed features (culverts, ditches, etc.)
  - Clearing, grading, and the addition of fill would significantly affect hydrology and artificially divert stream flows; reducing stream flow and impacting aquatic and terrestrial species (discussed under biological resources).
  - Increased storm water run-off and drainage from disruption of existing wetlands and tributaries as well as from topographical changes from earthwork construction (e.g., cut and fill).
  - Erosion and sedimentation could occur during construction activities.
  - Stream flows could be decreased, diverted, or increased, producing waterbody changes.
- Stream Restoration:
  - It would be difficult to incorporate natural stream mitigation practices to properly handle altered site drainage and convey storm water runoff.
  - The site may require lined channels, pipes, and concrete structures to convey runoff to existing streams.
  - Impact from removing/modifying existing streams would not be able to be completely restored to existing conditions.

The overall loss of a large quantity of surface waters and streams would be considered substantial and adequate mitigation may not be available.

C.3.6 Wetlands

A total of 113 freshwater wetland complexes encompassing 713 acres were delineated within the SERE East study area of approximately 5,483 acres. The most extensive wetlands were observed along the valley floor. All the wetlands identified were found to provide nutrient removal and transformation as well as providing wildlife habitat. Almost all of the wetlands provide groundwater discharge and/or recharge functions, flood flow alteration, and sediment and toxicant retention and production export (E&E, 2015b). Most wetlands at the SERE East site are dominated by native species, with little to no presence of non-native or invasive species. Most plant communities within the wetlands are relatively intact and well-functioning, although some vegetation senescence also present. In addition, as discussed in Section C.3.3, six vernal pools were identified in the study area, five were identified as significant vernal pools (E&E, 2015b).

Major impacts from construction of a CIS at the SERE East site were identified for wetlands including the following:

- Total direct wetland impacts at SERE East would include approximately 117 acres (within the CIS footprint).
- Several vernal pools could be filled or degraded by sedimentation.
- Potential indirect loss of nearby forested wetlands sensitive to changes in light, hydrology could occur.
- Wetland vegetation composition could change due to hydrology, filling, or sedimentation.
- The presence of non-native plant species could increase due to disturbances, such as changes in hydrology, sedimentation, and addition of fill.

The overall potential loss of a large quantity of wetlands would be considered a substantial loss that may not be mitigatable.

C.3.7 Visual/Aesthetics

The visual environment of the SERE East site includes characteristics of a rural, backcountry area with very minimal development and limited presence of military infrastructure (installation roads, small, scattered buildings, and historic buildings). The area is occupied by natural forest except in the specific locations of the few roads, buildings, and areas immediately surrounding water features such as Redington Pond. The SERE East site consists of a largely undeveloped, forested area in a relatively isolated area approximately 7.3 miles east-northeast of the town of Rangeley, Maine. A portion of the Appalachian National Scenic Trail passes through the southeast corner of the SERE East installation and is adjacent to the southeast corner of the CIS footprint. The area of the CIS footprint has the appearance of an undeveloped, mature forest covering mountainous slopes, bluff, and valley areas, with the gravel Redington Road being the main and most visible non-natural feature. The site is situated in a bowl formation around Redington Stream and surrounded by mountain peaks at higher elevation than the installation, many of which are visual points of interest along the Appalachian National Scenic Trail.

In addition to the Appalachian National Scenic Trail, there are two formally recognized aesthetic or visual resources on the SERE East site, Redington Falls and Redington Pond. Overall, site views are dominated by extensive areas of forest and mountain bluffs, peaks, and ridges with views of a streams, stream-wetlands complexes, vernal pools, and wetlands among its dense forest and steep slopes. As discussed in Section C.3.4, the SERE East installation includes Redington Village, a historic district which was determined to be eligible for listing in the NRHP. In addition, to the historic archaeological district, an additional 11 NRHP-eligible sites have been identified within the 5-mile APE viewshed for the CIS footprint (USDOI, 2014; Stell, 2015a). Nighttime lighting at the SERE East site is at the limited buildings present at the site for security purposes. There is almost no artificial lighting in the immediate vicinity of the SERE East site.

Major, some potentially unmitigatable, impacts from construction of a CIS at the SERE East site were identified for visual and aesthetics resources including the following:

- Based on daytime and nighttime simulations, visibility of proposed CIS buildings and clearing would be probable from several key observation points (KOPs): Saddleback Jr., The Horn, Mt. Abraham, Crocker Mountain, and Quill Hill. Several of these KOPs are located along the Appalachian Trail.
- Impacts could occur from nighttime lighting and sky glow as indicated during estimated simulations created for visualization.
- Major adverse impacts to visual resources, especially from the Appalachian National Scenic Trail, would occur during both day and night during construction and operation; these impacts could not be fully mitigated.

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Figure C.1-1 SERE East Training Area, Redington Township, ME

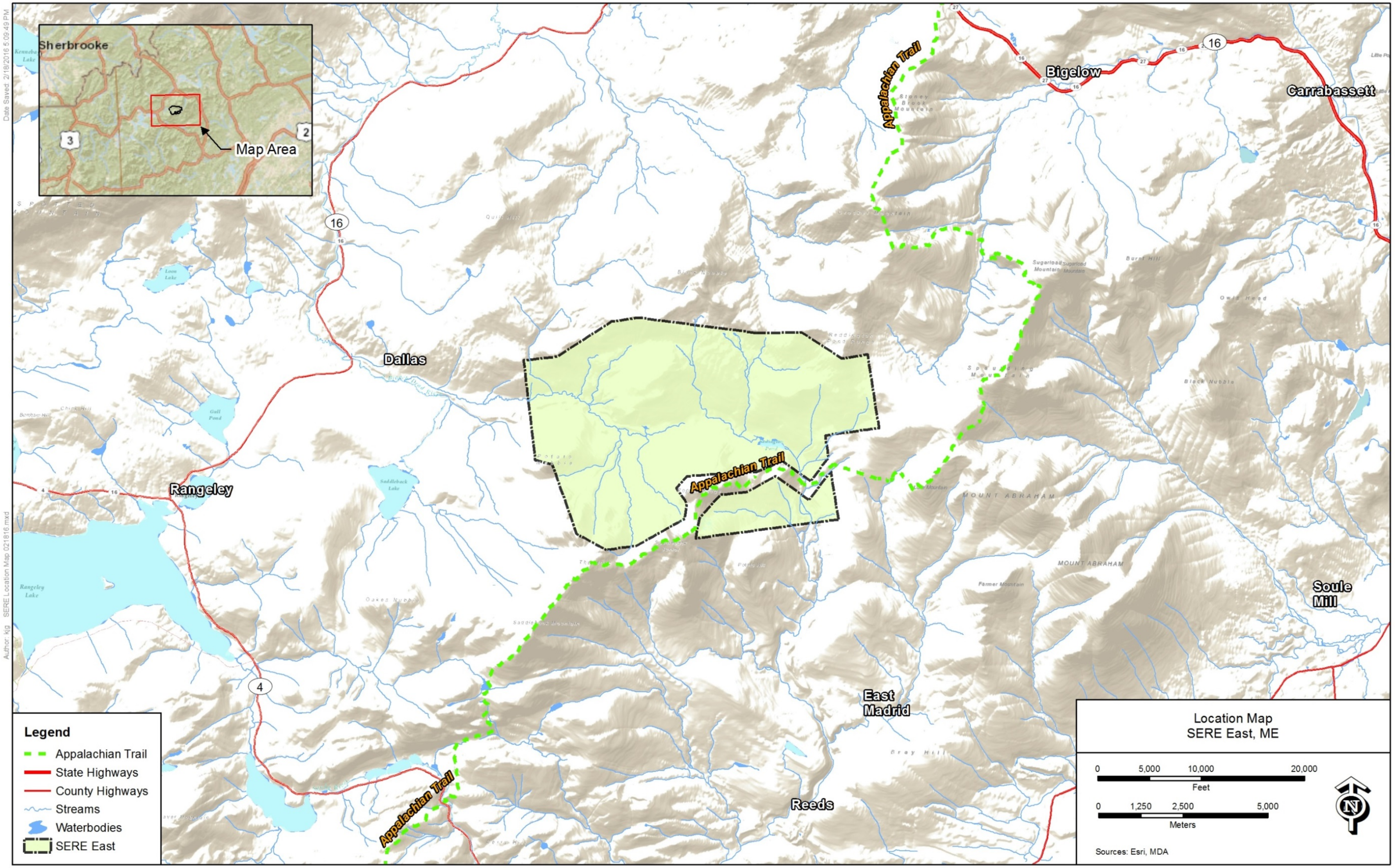
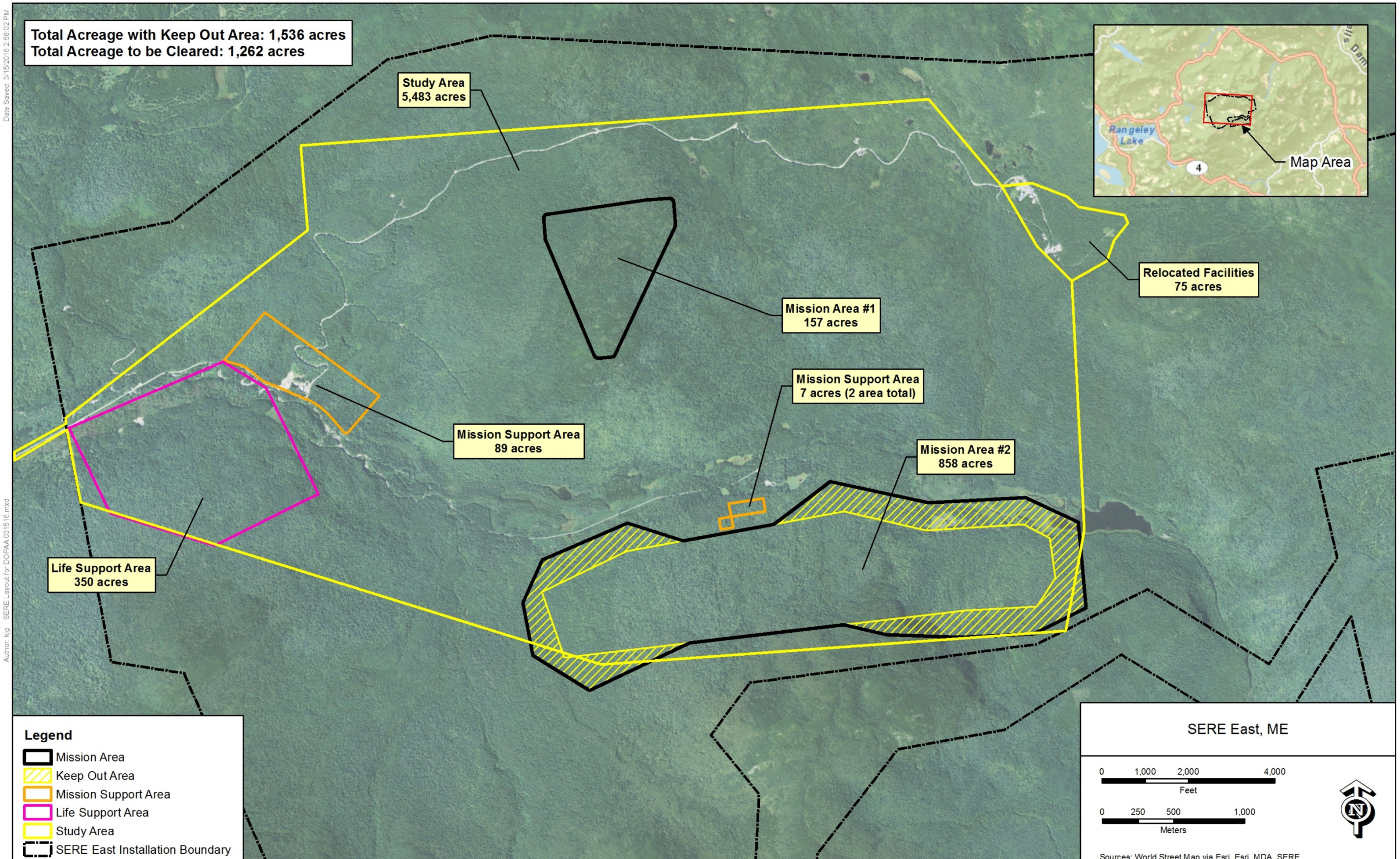


Figure C.1-2 SERE East Training Area Potential CIS Footprint and Notional Site Layout



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SERE East Designated as Alternative Considered but Not Carried Forward

16-NEWS-0001

January 15, 2016

The Missile Defense Agency has designated the Center for Security Forces Detachment Kittery Survival, Evasion, Resistance and Escape Facility (SERE East), Redington Township, Maine as an Alternative Considered, but Not Carried Forward for a potential additional missile interceptor site.

The MDA made this decision following extensive surveys conducted for development of a Draft Environmental Impact Statement (DEIS) to evaluate candidate sites for a potential future deployment of additional ground-based interceptors for homeland defense, as required by the fiscal year 2013 National Defense Authorization Act.

The MDA surveys, conducted in coordination with Federal and state agencies, included infrastructure, water resources, transportation access and other areas for assessing the suitability of a potential site. The SERE site presented irreversible environmental impacts, significant constructability concerns, and extensive costs associated with developing infrastructure in a remote area. Due to these factors, and in accordance with the National Environmental Policy Act process, the SERE East site will not be carried forward for further consideration.

Previously announced sites in New York, Ohio and Michigan will continue to be considered, and will be covered in the DEIS now in progress.

The Department of Defense has not made a decision to deploy or construct an additional interceptor site. Current sites in Alaska and California provide the necessary protection of the homeland from ballistic missile attack by countries such as North Korea and Iran. If a decision were to be made in the future to construct a new site, completing the required site studies and Environmental Impact Statement would shorten the timeline required to build such a site.

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APPENDIX D

AIR QUALITY SUPPORTING INFORMATION

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APPENDIX D.1

Construction Equipment Lists

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Table D-1 Preliminary Construction Equipment List Used for the Baseline Construction and Operation Air Emissions Analysis

Equipment List [1]	Tree Clearing [2]		Site Preparation [3]		Construction [4] [5]		Buildout [6]	
	Number of Equipment	Hours Per Day	Number of Equipment	Hours Per Day	Number of Equipment	Hours Per Day	Number of Equipment	Hours Per Day
Aerial Lift					4	3.28		
Air Compressor	3	3.14	3	3.14	5	6.31		
Bore/Drill			2	0.42	1	2.25	8	7.92
Concrete Mixer					1	0.57		
Concrete Saw					1	1.13		
Crane					21	2.15		
Crawler	4	3.04	7	3.04	11	4.16		
Crushing	2	3.21	1	3.21			1	0.62
Excavator	4	6.22	21	6.22	1	0.47		
General Industrial Equipment					1	2.39		
Generator Set					1	2.39		
Grader			1	5.59			1	1.31
Material Handling Equipment			3	3.24				
Off-Highway Truck	1	0.01	1	0.01				
Other Construction Equipment	1	0.30	1	0.30	11	1.87	2	0.14
Paving Equipment					8	1.62		
Plate Compactor					4	1.89		
Pump					12	6.05		
Roller			16	8.57			6	2.25
Rubber Tire Loader	2	1.86	2	1.86	16	3.48		
Scraper			1	8.66				
Surfacing Equipment					1	1.77		
Tractor					2	0.86		
Trencher			1	2.18	1	0.05		
Welder					22	8.88		

Notes:

1) The preliminary construction equipment list that is used for the construction and operation air emission analysis is based on previous MDA projects similar to the proposed action.
2) Tree clearing activities for the baseline construction emission estimate are assumed to commence in October of Year 1 and continue for 6 months.
3) Site preparation activities for the baseline construction emission estimate are assumed to commence during April of Year 2 and continue for twelve months.
4) The baseline construction phase activities (most intensive construction activities) are assumed to occur from April of Year 3 through March of Year 5.
5) During month 38 of the baseline construction phase there will be one month of paving activities that will require 5 paving equipment that operate 4.59 hours per day.
6) The buildout phase of the baseline construction emission estimate is assumed to begin during April of Year 5 and continue 12 months.

Table D-2 Preliminary Construction Equipment List Used for the Expedited Construction and Operation Air Emissions Analysis

Equipment List [1]	Tree Clearing [2]		Site Preparation [3]		Construction [4] [5]		Buildout [6]	
	Number of Equipment	Hours Per Day	Number of Equipment	Hours Per Day	Number of Equipment	Hours Per Day	Number of Equipment	Hours Per Day
Aerial Lift					4	6.56		
Air Compressor	3	6.28	3	6.28	5	12.62		
Bore/Drill			2	0.84	1	4.5	8	15.84
Concrete Mixer					1	1.14		
Concrete Saw					1	2.26		
Crane					21	4.3		
Crawler	4	6.08	7	6.08	11	8.32		
Crushing	2	6.42	1	6.42			1	1.24
Excavator	4	12.44	21	12.44	1	0.94		
General Industrial Equipment					1	4.78		
Generator Set					1	4.78		
Grader			1	11.18			1	2.62
Material Handling Equipment			3	6.48				
Off-Highway Truck	1	0.02	1	0.02				
Other Construction Equipment	1	0.60	1	0.60	11	3.74	2	0.28
Paving Equipment					8	3.24		
Plate Compactor					4	3.78		
Pump					12	12.10		
Roller			16	17.14			6	4.50
Rubber Tire Loader	2	3.72	2	3.72	16	6.96		
Scraper			1	17.32				
Surfacing Equipment					1	3.54		
Tractor					2	1.72		
Trencher			1	4.36	1	0.10		
Welder					22	17.76		

Notes:

1) The preliminary construction equipment list that is used for the construction and operation air emission analysis is based on previous MDA projects similar to the proposed action.
2) Tree clearing activities for the expedited construction emission estimate are assumed to commence in January of Year 2 and continue for 4 months.
3) Site preparation activities for the expedited construction emission estimate are assumed to commence during May of Year 2 and continue for 7 months.
4) The expedited construction phase activities (most intensive construction activities) are assumed to occur from December of Year 2 through February of Year 4.
5) During month 23 of the expedited construction phase there will be one month of paving activities that will require 5 paving equipment that operate 9.18 hours per day.
6) The buildout phase of the expedited construction emission estimate is assumed to begin during March of Year 4 and continue 7 months.

APPENDIX D.2

FCTC Site 1 and FCTC Site 2

Air Quality Calculations

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Construction – Baseline Schedule

FCTC Site 1

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FCTC Site 1 Construction CO_2 Emission Calculations

Baseline Schedule

Annual Emission Factors		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
		Emission Factors[1] (lb/hr)					
Activity	**Construction Equipment Name**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58	119.58	119.58	119.58
	Off-Highway Trucks	260.05	260.05	260.05	260.05	260.05	260.05
	Other Construction Equipment Composite	122.56	122.56	122.56	122.56	122.56	122.56
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58	119.58	119.58	119.58
	Graders Composite	132.74	132.74	132.74	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05	260.05	260.05	260.05
	Other Construction Equipment Composite	122.56	122.56	122.56	122.56	122.56	122.56
	Other Material Handling Equipment Composite	141.19	141.19	141.19	141.19	141.19	141.19
	Rollers Composite	67.048	67.048	67.048	67.048	67.048	67.048
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.89	164.89	164.89	164.89	164.89	164.89
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74	132.74	132.74	132.74
	Other Construction Equipment Composite	122.54	122.54	122.54	122.54	122.54	122.54
	Rollers Composite	67.048	67.048	67.048	67.048	67.048	67.048

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.02 program.

Annual Estimated Emissions										Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Activity	**Construction Equipment Name[1]**	**Number of Equipment Pieces[2]**	**Year 1 Days/yr[3]**	**Year 2 Days/yr[3]**	**Year 3 Days/yr[3]**	**Year 4 Days/yr[3]**	**Year 5 Days/yr[3]**	**Year 6 Days/yr[3]**	**Equipment Use (hpd)[2]**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**
Tree Clearing (Months 1-6)	Air Compressors Composite	3	78	78	0	0	0	0	3.14	21.199	21.199	0.000	0.000	0.000	0.000
	Crawler Tractors Composite	4	78	78	0	0	0	0	3.04	49.050	49.050	0.000	0.000	0.000	0.000
	Crushing/Proc Equipment Composite	2	78	78	0	0	0	0	3.21	30.051	30.051	0.000	0.000	0.000	0.000
	Excavators Composite	4	78	78	0	0	0	0	6.22	105.262	105.262	0.000	0.000	0.000	0.000
	Off-Highway Trucks	1	78	78	0	0	0	0	0.01	0.092	0.092	0.000	0.000	0.000	0.000
	Other Construction Equipment Composite	1	78	78	0	0	0	0	0.30	1.301	1.301	0.000	0.000	0.000	0.000
	Rubber Tire Loaders Composite	2	78	78	0	0	0	0	1.86	14.295	14.295	0.000	0.000	0.000	0.000
Site Prep (Months 7-18)	Air Compressors Composite	3	0	234	78	0	0	0	3.14	0.000	63.597	21.199	0.000	0.000	0.000
	Bore/Drill Rigs Composite	2	0	234	78	0	0	0	0.42	0.000	14.702	4.901	0.000	0.000	0.000
	Crawler Tractors Composite	7	0	234	78	0	0	0	3.04	0.000	257.512	85.837	0.000	0.000	0.000
	Crushing/Proc Equipment Composite	1	0	234	78	0	0	0	3.21	0.000	45.076	15.025	0.000	0.000	0.000
	Excavators Composite	21	0	234	78	0	0	0	6.22	0.000	1657.870	552.623	0.000	0.000	0.000
	Graders Composite	1	0	234	78	0	0	0	5.59	0.000	78.758	26.253	0.000	0.000	0.000
	Off-Highway Trucks	1	0	234	78	0	0	0	0.01	0.000	0.276	0.092	0.000	0.000	0.000
	Other Construction Equipment Composite	1	0	234	78	0	0	0	0.30	0.000	3.903	1.301	0.000	0.000	0.000
	Other Material Handling Equipment Composite	3	0	234	78	0	0	0	3.24	0.000	145.664	48.555	0.000	0.000	0.000
	Rollers Composite	16	0	234	78	0	0	0	8.57	0.000	975.818	325.273	0.000	0.000	0.000
	Rubber Tire Loaders Composite	2	0	234	78	0	0	0	1.86	0.000	42.884	14.295	0.000	0.000	0.000
	Scrapers Composite	1	0	234	78	0	0	0	8.66	0.000	241.266	80.422	0.000	0.000	0.000
	Trenchers Composite	1	0	234	78	0	0	0	2.18	0.000	13.586	4.529	0.000	0.000	0.000
Construction (Months 19-42)	Aerial Lifts Composite	4	0	0	234	312	78	0	3.28	0.000	0.000	48.351	64.468	16.117	0.000
	Air Compressors Composite	5	0	0	234	312	78	0	6.31	0.000	0.000	213.003	284.004	71.001	0.000
	Bore/Drill Rigs Composite	1	0	0	234	312	78	0	2.25	0.000	0.000	39.378	52.505	13.126	0.000
	Concrete and Mortar Mixers	1	0	0	234	312	78	0	0.57	0.000	0.000	0.439	0.585	0.146	0.000
	Concrete/Industrial Saws Composite	1	0	0	234	312	78	0	1.13	0.000	0.000	7.012	9.349	2.337	0.000
	Cranes	21	0	0	234	312	78	0	2.15	0.000	0.000	616.380	821.840	205.460	0.000
	Crawler Tractors Composite	11	0	0	234	312	78	0	4.16	0.000	0.000	553.747	738.329	184.582	0.000
	Excavators Composite	1	0	0	234	312	78	0	0.47	0.000	0.000	5.965	7.953	1.988	0.000
	Generator Sets Composite	1	0	0	234	312	78	0	2.39	0.000	0.000	15.472	20.630	5.157	0.000
	Other Construction Equipment Composite	11	0	0	234	312	78	0	1.87	0.000	0.000	267.543	356.725	89.181	0.000
	Other General Industrial Equipment Composite	1	0	0	234	312	78	0	2.39	0.000	0.000	38.617	51.490	12.872	0.000
	Paving Equipment Composite	8	0	0	234	312	78	0	1.62	0.000	0.000	94.833	126.444	31.611	0.000
	Plate Compactors Composite	4	0	0	234	312	78	0	1.89	0.000	0.000	3.461	4.615	1.154	0.000
	Pumps Composite	12	0	0	234	312	78	0	6.05	0.000	0.000	382.255	509.673	127.418	0.000
	Rubber Tire Loaders Composite	16	0	0	234	312	78	0	3.48	0.000	0.000	641.876	855.835	213.959	0.000
	Surfacing Equipment Composite	1	0	0	234	312	78	0	1.77	0.000	0.000	31.179	41.572	10.393	0.000
	Tractors/Loaders/Backhoes Composite	2	0	0	234	312	78	0	0.86	0.000	0.000	12.195	16.259	4.065	0.000
	Trenchers Composite	1	0	0	234	312	78	0	0.05	0.000	0.000	0.312	0.415	0.104	0.000
	Welders Composite	22	0	0	234	312	78	0	8.88	0.000	0.000	530.874	707.832	176.958	0.000
1-Mo Construction (Month 38)	Paving Composite	5	0	0	0	26	0	0	4.59	0.000	0.000	0.000	18.659	0.000	0.000
Buildout (Months 43-54)	Bore/Drill Rigs Composite	8	0	0	0	0	234	78	7.92	0.000	0.000	0.000	0.000	1108.898	369.633
	Crushing/Proc Equipment Composite	1	0	0	0	0	234	78	0.62	0.000	0.000	0.000	0.000	8.706	2.902
	Graders Composite	1	0	0	0	0	234	78	1.31	0.000	0.000	0.000	0.000	18.457	6.152
	Other Construction Equipment Composite	2	0	0	0	0	234	78	0.14	0.000	0.000	0.000	0.000	3.642	1.214
	Rollers Composite	6	0	0	0	0	234	78	2.25	0.000	0.000	0.000	0.000	96.073	32.024
										Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Total CO2 Tons Emissions from Construction Equipment										**221.25**	**3,762.16**	**4,683.20**	**4,689.18**	**2,403.41**	**411.93**

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.

2. The analysis assumes that construction will occur 26 days per month. The EIS construction schedule states each piece of construction equipment is limited to a 10-hour per day schedule. Therefore, if an individual piece operates more that 10 hours per day during any of the four buildout periods, additional pieces of that same equipment will be used in the calculations, so that the total hours per day for each piece of equipment is always less than 10-hours per day.

3. Total days per year was determined by the construction schedule working 6 days a week per the EIS construction schedule.

FCTC Site 1 Construction Worker Vehicle Estimated Emissions

Baseline Schedule

Air Emissions Estimate for Worker Vehicles duirng Construciton

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.492	0.012	0.013	0.502	4.997	359.802	0.007	0.429	0.011	0.013	0.372	4.342	351.890	0.002	0.385	0.010	0.011	0.319	4.071	343.442	0.002
Light-Duty Trucks	0.653	0.013	0.015	0.883	7.325	470.513	0.009	0.559	0.013	0.015	0.636	6.358	457.034	0.003	0.496	0.012	0.014	0.549	5.830	443.649	0.003

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.347	0.009	0.010	0.274	3.825	334.459	0.002	0.315	0.008	0.009	0.238	3.616	325.00	0.002	0.315	0.008	0.009	0.238	3.616	325.00	0.002
Light-Duty Trucks	0.443	0.011	0.013	0.475	5.362	430.939	0.003	0.399	0.010	0.012	0.415	4.974	418.705	0.003	0.399	0.010	0.012	0.415	4.974	418.705	0.003

Estimated Annual Air Emissions: Oct. - Dec for Year 1, Jan.-Mar. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]					
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Passenger Cars	50	78	78	78	50	50	200	300	300	200
Light-Duty Trucks	50	78	78	78	50	50	200	300	300	200

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	0.1058	0.0026	0.0028	0.1079	1.0741	70.1614	0.0015	0.0922	0.0024	0.0028	0.0800	0.9333	68.619	0.0004	0.3310	0.0086	0.0095	0.2743	3.5003	267.885	0.0017
Light-Duty Trucks	0.1404	0.0028	0.0032	0.1898	1.5745	91.75	0.0019	0.1202	0.0028	0.0032	0.1367	1.3667	89.12	0.0006	0.4265	0.0103	0.0120	0.4720	5.0127	346.05	0.0026
Total Annual Emissions from Worker Vehicles	0.2461	0.0054	0.0060	0.2977	2.6486	161.91	0.0034	0.2124	0.0052	0.0060	0.2167	2.3000	157.74	0.0011	0.7575	0.0189	0.0215	0.7463	8.5129	613.93	0.0043

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	0.4475	0.0116	0.0129	0.3534	4.9331	391.317	0.0026	0.4063	0.0103	0.0116	0.3069	4.6636	#######	0.0026	0.2708	0.0069	0.0077	0.2046	3.1090	#######	0.0017
Light-Duty Trucks	0.5713	0.0142	0.0168	0.6126	6.9154	504.20	0.0039	0.5146	0.0129	0.0155	0.5352	6.4150	489.88	0.0039	0.3431	0.0086	0.0103	0.3568	4.2767	326.59	0.0026
Total Annual Emissions from Worker Vehicles	1.0189	0.0258	0.0297	0.9660	11.8485	895.52	0.0064	0.9208	0.0232	0.0271	0.8422	11.0786	870.14	0.0064	0.6139	0.0155	0.0181	0.5615	7.3857	580.09	0.0043

Estimated Annual Air Emissions: Apr.-Dec. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]					
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Passenger Cars	50	234	234	234	0	200	300	300	200	0
Light-Duty Trucks	50	234	234	234	0	200	300	300	200	0

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.1066	0.0284	0.0335	0.9595	11.1998	823.423	0.0052	1.4896	0.0387	0.0426	1.2342	15.7512	1205.48	0.0077
Light-Duty Trucks	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.4419	0.0335	0.0387	1.6405	16.3999	1069.46	0.0077	1.9191	0.0464	0.0542	2.1241	22.5569	1557.21	0.0116
Total Annual Emissions from Worker Vehicles	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	2.5485	0.0619	0.0722	2.6000	27.5997	1892.88	0.0129	3.4087	0.0851	0.0967	3.3584	38.3081	2762.69	0.0193

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	1.3426	0.0348	0.0387	1.0601	14.7994	#######	0.0077	0.8125	0.0206	0.0232	0.6139	9.3271	760.502	0.0052	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	1.7140	0.0426	0.0503	1.8378	20.7462	1512.60	0.0116	1.0292	0.0258	0.0310	1.0705	12.8300	979.77	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
Total Annual Emissions from Worker Vehicles	3.0566	0.0774	0.0890	2.8980	35.5455	2686.55	0.0193	1.8417	0.0464	0.0542	1.6844	22.1571	1740.27	0.0129	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000

Notes [ ]:

1. Kalamazoo and Calhoun County emission Factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model.
   The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2016 emission factors are used for Year 1, 2017 for Year 2, 2018 for Year 3, 2019 for Year 4, 2020 for Year 5, and 2020 for Year 6.
2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling within the non-attainment/maintenance area to and from the FCTC Site 1.
4. It is assumed that each month contains 26 work days, working 6 days a week over an average year of 365 days.
5. Trips/Day are based on monthly project estimates for the expected distribution of workers averaged over each year of the expected construction schedule. The analysis uses one-hundred
   workers during months 1-6 starting in Oct of Year 1, 400 construction workers during months 7-18 starting in April of Year 2, 600 workers during months 19-42 April of Year 3, and 400 construciton workers during months 43-54 starting in April of Year 5.
6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 1 On-Road Haul/Delivery Truck Estimated Emissions

Baseline Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks duirng Construciton

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.698	0.272	0.295	7.350	2.369	1538.27	0.014	0.639	0.238	0.259	6.682	2.181	1523.74	0.013	0.583	0.206	0.224	6.048	2.008	1509.30	0.013

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.535	0.179	0.195	5.489	1.858	1495.96	0.013	0.492	0.156	0.170	4.988	1.726	1483.52	0.013	0.492	0.156	0.170	4.988	1.726	1483.52	0.013

Estimated Annual Air Emissions: Oct. - Dec for Year 1, Jan.-Mar. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]					
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
HDDV	20	78	78	78	90	90	90	90	90	90

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2
HDDV	0.1080	0.0421	0.0457	1.1375	0.3666	#######	0.0022	0.0989	0.0368	0.0401	1.0341	0.3375	213.933	0.0020	0.0902	0.0319	0.0347	0.9360	0.3108	211.905	0.0020
Total Annual Emissions from Worker Vehicles	0.1080	0.0421	0.0457	1.1375	0.3666	215.97	0.0022	0.0989	0.0368	0.0401	1.0341	0.3375	213.93	0.0020	0.0902	0.0319	0.0347	0.9360	0.3108	211.91	0.0020

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2
HDDV	0.0828	0.0277	0.0302	0.8495	0.2876	210.032	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	#######	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	#######	0.0020
Total Annual Emissions from Worker Vehicles	0.0828	0.0277	0.0302	0.8495	0.2876	210.03	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	208.29	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	208.29	0.0020

Estimated Annual Air Emissions: Apr.-Dec. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]					
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
HDDV	20	234	234	234	0	90	90	90	90	0

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2
HDDV	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.2967	0.1105	0.1203	3.1024	1.0126	641.799	0.0060	0.2707	0.0956	0.1040	2.8080	0.9323	635.72	0.0060
Total Annual Emissions from Worker Vehicles	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.2967	0.1105	0.1203	3.1024	1.0126	641.80	0.0060	0.2707	0.0956	0.1040	2.8080	0.9323	635.72	0.0060

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2
HDDV	0.2484	0.0831	0.0905	2.5485	0.8627	630.096	0.0060	0.2284	0.0724	0.0789	2.3159	0.8014	624.857	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Total Annual Emissions from Worker Vehicles	0.2484	0.0831	0.0905	2.5485	0.8627	630.10	0.0060	0.2284	0.0724	0.0789	2.3159	0.8014	624.86	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000

Notes [ ]:

1. Kalamazoo and Calhoun County emission Factors for Heavy Duty Diesel Viehecles (HDDV) are from USAF 's ACAM model.
   The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2016 emission factors are used for Year 1, 2017 for Year 2, 2018 for Year 3, 2019 for Year 4, 2020 for Year 5, and 2020 for Year 6.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the FCTC Site 1 site to an offsite dump location.
4. It is assumed that each month contains 26 work days, working 6 days a week over an average year of 365 days.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are assumed for all years of construction. It is assumed that the on road haul/delivery trucks wil be used to removed construction waste from the site, deliver construction materials to the site, and other types of activities during construction.
6. Tree clearing is expected start in October of Year 1 to April of Year 2. Site preparation is expected to take place starting in April of Year 2 through March of Year 3. Heavy construction is expected to start in April of Year 3 through March of Year 5. Buildout is expected to start in April of Year 5 through March of Year 6.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 1 Total Emissions

Baseline Schedule

FCTC Site 1 Estimated Air Emissions During Construction

Year 1

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	0.23	0.25	0.11	0.59
NO_X	1.59	0.30	1.14	3.03
SO_X	0.003	0.003	0.002	0.009
$PM_{2.5}$	0.09	0.01	0.04	0.14
PM_{10}	0.09	0.01	0.05	0.14
CO	1.12	2.65	0.37	4.13
CO_2e (4)	221.25	161.91	215.97	599.13

Year 2

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	3.75	2.76	0.40	6.91
NO_X	25.07	2.82	4.14	32.02
SO_X	0.044	0.014	0.008	0.066
$PM_{2.5}$	1.39	0.07	0.15	1.60
PM_{10}	3,768.79	0.08	0.16	3,769.02
CO	19.42	29.90	1.35	50.67
CO_2e (4)	3,762.16	2,050.62	855.73	6,668.51

Year 3

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	4.83	4.17	0.36	9.35
NO_X	31.80	4.10	3.74	39.65
SO_X	0.055	0.024	0.008	0.087
$PM_{2.5}$	1.75	0.10	0.13	1.98
PM_{10}	1,257.55	0.12	0.14	1,257.80
CO	24.15	46.82	1.24	72.21
CO_2e (4)	4,683.20	3,376.62	847.62	8,907.44

Year 4

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	4.93	4.08	0.33	9.34
NO_X	32.14	3.86	3.40	39.40
SO_X	0.055	0.026	0.008	0.089
$PM_{2.5}$	1.76	0.10	0.11	1.98
PM_{10}	1.76	0.12	0.12	2.00
CO	24.21	47.39	1.15	72.75
CO_2e (4)	4,689.18	3,582.06	840.13	9,111.37

Year 5

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	1.69	2.76	0.30	4.76
NO_X	11.28	2.53	3.09	16.90
SO_X	0.028	0.019	0.008	0.055
$PM_{2.5}$	0.53	0.07	0.10	0.69
PM_{10}	0.53	0.08	0.11	0.71
CO	10.48	33.24	1.07	44.78
CO_2e (4)	2,403.41	2,610.41	833.14	5,846.96

Year 6

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	0.16	0.61	0.08	0.85
NO_X	1.10	0.56	0.77	2.43
SO_X	0.005	0.004	0.002	0.011
$PM_{2.5}$	0.03	0.02	0.02	0.07
PM_{10}	0.03	0.02	0.03	0.07
CO	1.49	7.39	0.27	9.14
CO_2e (4)	411.93	580.09	208.29	1,200.30

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculted in the tabs on this spreadsheet using emission factors from ACAM 5.02 and is given in metric tons.

Construction – Baseline Schedule

FCTC Site 2

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FCTC Site 2 Construction CO_2 Emission Calculations

Baseline Schedule

Annual Emission Factors		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
		Emission Factors[1] (lb/hr)					
Activity	**Construction Equipment Name**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**	**CO2**
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58	119.58	119.58	119.58
	Off-Highway Trucks	260.05	260.05	260.05	260.05	260.05	260.05
	Other Construction Equipment Composite	122.56	122.56	122.56	122.56	122.56	122.56
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58	119.58	119.58	119.58
	Graders Composite	132.74	132.74	132.74	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05	260.05	260.05	260.05
	Other Construction Equipment Composite	122.56	122.56	122.56	122.56	122.56	122.56
	Other Material Handling Equipment Composite	141.19	141.19	141.19	141.19	141.19	141.19
	Rollers Composite	67.046	67.046	67.046	67.046	67.046	67.046
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.86	164.86	164.86	164.86	164.86	164.86
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74	132.74	132.74	132.74
	Other Construction Equipment Composite	122.49	122.49	122.49	122.49	122.49	122.49
	Rollers Composite	67.04	67.04	67.04	67.04	67.04	67.04

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.02 program.

Annual Estimated Emissions										Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Activity	**Construction Equipment Name[1]**	**Number of Equipment Pieces[2]**	**Year 1 Days/yr[3]**	**Year 2 Days/yr[3]**	**Year 3 Days/yr[3]**	**Year 4 Days/yr[3]**	**Year 5 Days/yr[3]**	**Year 6 Days/yr[3]**	**Equipment Use (hpd)[2]**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**
Tree Clearing (Months 1-6)	Air Compressors Composite	3	78	78	0	0	0	0	3.14	21.199	21.199	0.000	0.000	0.000	0.000
	Crawler Tractors Composite	4	78	78	0	0	0	0	3.04	49.050	49.050	0.000	0.000	0.000	0.000
	Crushing/Proc Equipment Composite	2	78	78	0	0	0	0	3.21	30.051	30.051	0.000	0.000	0.000	0.000
	Excavators Composite	4	78	78	0	0	0	0	6.22	105.262	105.262	0.000	0.000	0.000	0.000
	Off-Highway Trucks	1	78	78	0	0	0	0	0.01	0.092	0.092	0.000	0.000	0.000	0.000
	Other Construction Equipment Composite	1	78	78	0	0	0	0	0.30	1.301	1.301	0.000	0.000	0.000	0.000
	Rubber Tire Loaders Composite	2	78	78	0	0	0	0	1.86	14.295	14.295	0.000	0.000	0.000	0.000
Site Prep (Months 7-18)	Air Compressors Composite	3	0	234	78	0	0	0	3.14	0.000	63.597	21.199	0.000	0.000	0.000
	Bore/Drill Rigs Composite	2	0	234	78	0	0	0	0.42	0.000	14.702	4.901	0.000	0.000	0.000
	Crawler Tractors Composite	7	0	234	78	0	0	0	3.04	0.000	257.512	85.837	0.000	0.000	0.000
	Crushing/Proc Equipment Composite	1	0	234	78	0	0	0	3.21	0.000	45.076	15.025	0.000	0.000	0.000
	Excavators Composite	21	0	234	78	0	0	0	6.22	0.000	1657.870	552.623	0.000	0.000	0.000
	Graders Composite	1	0	234	78	0	0	0	5.59	0.000	78.758	26.253	0.000	0.000	0.000
	Off-Highway Trucks	1	0	234	78	0	0	0	0.01	0.000	0.276	0.092	0.000	0.000	0.000
	Other Construction Equipment Composite	1	0	234	78	0	0	0	0.30	0.000	3.903	1.301	0.000	0.000	0.000
	Other Material Handling Equipment Composite	3	0	234	78	0	0	0	3.24	0.000	145.664	48.555	0.000	0.000	0.000
	Rollers Composite	16	0	234	78	0	0	0	8.57	0.000	975.789	325.263	0.000	0.000	0.000
	Rubber Tire Loaders Composite	2	0	234	78	0	0	0	1.86	0.000	42.884	14.295	0.000	0.000	0.000
	Scrapers Composite	1	0	234	78	0	0	0	8.66	0.000	241.266	80.422	0.000	0.000	0.000
	Trenchers Composite	1	0	234	78	0	0	0	2.18	0.000	13.586	4.529	0.000	0.000	0.000
Construction (Months 19-42)	Aerial Lifts Composite	4	0	0	234	312	78	0	3.28	0.000	0.000	48.351	64.468	16.117	0.000
	Air Compressors Composite	5	0	0	234	312	78	0	6.31	0.000	0.000	213.003	284.004	71.001	0.000
	Bore/Drill Rigs Composite	1	0	0	234	312	78	0	2.25	0.000	0.000	39.378	52.505	13.126	0.000
	Concrete and Mortar Mixers	1	0	0	234	312	78	0	0.57	0.000	0.000	0.439	0.585	0.146	0.000
	Concrete/Industrial Saws Composite	1	0	0	234	312	78	0	1.13	0.000	0.000	7.012	9.349	2.337	0.000
	Cranes	21	0	0	234	312	78	0	2.15	0.000	0.000	616.380	821.840	205.460	0.000
	Crawler Tractors Composite	11	0	0	234	312	78	0	4.16	0.000	0.000	553.747	738.329	184.582	0.000
	Excavators Composite	1	0	0	234	312	78	0	0.47	0.000	0.000	5.965	7.953	1.988	0.000
	Generator Sets Composite	1	0	0	234	312	78	0	2.39	0.000	0.000	15.472	20.630	5.157	0.000
	Other Construction Equipment Composite	11	0	0	234	312	78	0	1.87	0.000	0.000	267.543	356.725	89.181	0.000
	Other General Industrial Equipment Composite	1	0	0	234	312	78	0	2.39	0.000	0.000	38.617	51.490	12.872	0.000
	Paving Equipment Composite	8	0	0	234	312	78	0	1.62	0.000	0.000	94.833	126.444	31.611	0.000
	Plate Compactors Composite	4	0	0	234	312	78	0	1.89	0.000	0.000	3.461	4.615	1.154	0.000
	Pumps Composite	12	0	0	234	312	78	0	6.05	0.000	0.000	382.255	509.673	127.418	0.000
	Rubber Tire Loaders Composite	16	0	0	234	312	78	0	3.48	0.000	0.000	641.876	855.835	213.959	0.000
	Surfacing Equipment Composite	1	0	0	234	312	78	0	1.77	0.000	0.000	31.179	41.572	10.393	0.000
	Tractors/Loaders/Backhoes Composite	2	0	0	234	312	78	0	0.86	0.000	0.000	12.195	16.259	4.065	0.000
	Trenchers Composite	1	0	0	234	312	78	0	0.05	0.000	0.000	0.312	0.415	0.104	0.000
	Welders Composite	22	0	0	234	312	78	0	8.88	0.000	0.000	530.874	707.832	176.958	0.000
1-Mo Construction (Month 38)	Paving Composite	5	0	0	0	26	0	0	4.59	0.000	0.000	0.000	18.659	0.000	0.000
Buildout (Months 43-54)	Bore/Drill Rigs Composite	8	0	0	0	0	234	78	7.92	0.000	0.000	0.000	0.000	1108.696	369.565
	Crushing/Proc Equipment Composite	1	0	0	0	0	234	78	0.62	0.000	0.000	0.000	0.000	8.706	2.902
	Graders Composite	1	0	0	0	0	234	78	1.31	0.000	0.000	0.000	0.000	18.457	6.152
	Other Construction Equipment Composite	2	0	0	0	0	234	78	0.14	0.000	0.000	0.000	0.000	3.640	1.213
	Rollers Composite	6	0	0	0	0	234	78	2.25	0.000	0.000	0.000	0.000	96.062	32.021
										Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Total CO2 Tons Emissions from Construction Equipment										**221.25**	**3,762.13**	**4,683.19**	**4,689.18**	**2,403.19**	**411.85**

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.

2. The analysis assumes that construction will occur 26 days per month. The EIS construction schedule states each piece of construction equipment is limited to a 10-hour per day schedule. Therefore, if an individual piece operates more that 10 hours per day during any of the four buildout periods, additional pieces of that same equipment will be used in the calculations, so that the total hours per day for each piece of equipment is always less than 10-hours per day.

3. Total days per year was determined by the construction schedule working 6 days a week per the EIS construction schedule.

FCTC Site 2 Construction Worker Vehicle Estimated Emissions

Baseline Schedule

Air Emissions Estimate for Worker Vehicles duirng Construciton

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 1 VOC	Year 1 $PM_{2.5}$	Year 1 PM_{10}	Year 1 NOx	Year 1 CO	Year 1 CO_2	Year 1 SO_2	Year 2 VOC	Year 2 $PM_{2.5}$	Year 2 PM_{10}	Year 2 NOx	Year 2 CO	Year 2 CO_2	Year 2 SO_2	Year 3 VOC	Year 3 $PM_{2.5}$	Year 3 PM_{10}	Year 3 NOx	Year 3 CO	Year 3 CO_2	Year 3 SO_2
Passenger Cars	0.492	0.012	0.013	0.502	4.997	359.802	0.007	0.429	0.011	0.013	0.372	4.342	351.890	0.002	0.385	0.010	0.011	0.319	4.071	343.442	0.002
Light-Duty Trucks	0.653	0.013	0.015	0.883	7.325	470.513	0.009	0.559	0.013	0.015	0.636	6.358	457.034	0.003	0.496	0.012	0.014	0.549	5.830	443.649	0.003

Vehicle Type	Year 4 VOC	Year 4 $PM_{2.5}$	Year 4 PM_{10}	Year 4 NOx	Year 4 CO	Year 4 CO_2	Year 4 SO_2	Year 5 VOC	Year 5 $PM_{2.5}$	Year 5 PM_{10}	Year 5 NOx	Year 5 CO	Year 5 CO_2	Year 5 SO_2	Year 6 VOC	Year 6 $PM_{2.5}$	Year 6 PM_{10}	Year 6 NOx	Year 6 CO	Year 6 CO_2	Year 6 SO_2
Passenger Cars	0.347	0.009	0.010	0.274	3.825	334.459	0.002	0.315	0.008	0.009	0.238	3.616	325.00	0.002	0.315	0.008	0.009	0.238	3.616	325.00	0.002
Light-Duty Trucks	0.443	0.011	0.013	0.475	5.362	430.939	0.003	0.399	0.010	0.012	0.415	4.974	418.705	0.003	0.399	0.010	0.012	0.415	4.974	418.705	0.003

Estimated Annual Air Emissions: Oct. - Dec for Year 1, Jan.-Mar. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4] Years 1-3	Days/Year[4] Year 4	Days/Year[4] Years 5-6	Trips/Day[5,6] Year 1	Trips/Day[5,6] Year 2	Trips/Day[5,6] Year 3	Trips/Day[5,6] Year 4	Trips/Day[5,6] Year 5	Trips/Day[5,6] Year 6	Year 1 VOC	Year 1 $PM_{2.5}$	Year 1 PM_{10}	Year 1 NO_x	Year 1 CO	Year 1 CO_2 (7)	Year 1 SO_2
Passenger Cars	50	78	78	78	50	50	200	300	300	200	0.1058	0.0026	0.0028	0.1079	1.0741	70.1614	0.0015
Light-Duty Trucks	50	78	78	78	50	50	200	300	300	200	0.1404	0.0028	0.0032	0.1898	1.5745	91.75	0.0019
Total Annual Emissions from Worker Vehicles											0.2461	0.0054	0.0060	0.2977	2.6486	161.91	0.0034

Vehicle Type	Year 2 VOC	Year 2 $PM_{2.5}$	Year 2 PM_{10}	Year 2 NO_x	Year 2 CO	Year 2 CO_2 (7)	Year 2 SO_2	Year 3 VOC	Year 3 $PM_{2.5}$	Year 3 PM_{10}	Year 3 NO_x	Year 3 CO	Year 3 CO_2 (7)	Year 3 SO_2
Passenger Cars	0.0922	0.0024	0.0028	0.0800	0.9333	68.619	0.0004	0.3310	0.0086	0.0095	0.2743	3.5003	267.885	0.0017
Light-Duty Trucks	0.1202	0.0028	0.0032	0.1367	1.3667	89.12	0.0006	0.4265	0.0103	0.0120	0.4720	5.0127	346.05	0.0026
Total Annual Emissions from Worker Vehicles	0.2124	0.0052	0.0060	0.2167	2.3000	157.74	0.0011	0.7575	0.0189	0.0215	0.7463	8.5129	613.93	0.0043

Vehicle Type	Year 4 VOC	Year 4 $PM_{2.5}$	Year 4 PM_{10}	Year 4 NO_x	Year 4 CO	Year 4 CO_2 (7)	Year 4 SO_2	Year 5 VOC	Year 5 $PM_{2.5}$	Year 5 PM_{10}	Year 5 NO_x	Year 5 CO	Year 5 CO_2 (7)	Year 5 SO_2	Year 6 VOC	Year 6 $PM_{2.5}$	Year 6 PM_{10}	Year 6 NO_x	Year 6 CO	Year 6 CO_2 (7)	Year 6 SO_2
Passenger Cars	0.4475	0.0116	0.0129	0.3534	4.9331	391.317	0.0026	0.4063	0.0103	0.0116	0.3069	4.6636	#######	0.0026	0.2708	0.0069	0.0077	0.2046	3.1090	#######	0.0017
Light-Duty Trucks	0.5713	0.0142	0.0168	0.6126	6.9154	504.20	0.0039	0.5146	0.0129	0.0155	0.5352	6.4150	489.88	0.0039	0.3431	0.0086	0.0103	0.3568	4.2767	326.59	0.0026
Total Annual Emissions from Worker Vehicles	1.0189	0.0258	0.0297	0.9660	11.8485	895.52	0.0064	0.9208	0.0232	0.0271	0.8422	11.0786	870.14	0.0064	0.6139	0.0155	0.0181	0.5615	7.3857	580.09	0.0043

Estimated Annual Air Emissions: Apr.-Dec. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4] Years 1-3	Days/Year[4] Year 4	Days/Year[4] Years 5-6	Trips/Day[5,6] Year 1	Trips/Day[5,6] Year 2	Trips/Day[5,6] Year 3	Trips/Day[5,6] Year 4	Trips/Day[5,6] Year 5	Trips/Day[5,6] Year 6	Year 1 VOC	Year 1 $PM_{2.5}$	Year 1 PM_{10}	Year 1 NO_x	Year 1 CO	Year 1 CO_2 (7)	Year 1 SO_2
Passenger Cars	50	234	234	234	0	200	300	300	200	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
Light-Duty Trucks	50	234	234	234	0	200	300	300	200	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
Total Annual Emissions from Worker Vehicles											0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000

Vehicle Type	Year 2 VOC	Year 2 $PM_{2.5}$	Year 2 PM_{10}	Year 2 NO_x	Year 2 CO	Year 2 CO_2 (7)	Year 2 SO_2	Year 3 VOC	Year 3 $PM_{2.5}$	Year 3 PM_{10}	Year 3 NO_x	Year 3 CO	Year 3 CO_2 (7)	Year 3 SO_2
Passenger Cars	1.1066	0.0284	0.0335	0.9595	11.1998	823.423	0.0052	1.4896	0.0387	0.0426	1.2342	15.7512	1205.48	0.0077
Light-Duty Trucks	1.4419	0.0335	0.0387	1.6405	16.3999	1069.46	0.0077	1.9191	0.0464	0.0542	2.1241	22.5569	1557.21	0.0116
Total Annual Emissions from Worker Vehicles	2.5485	0.0619	0.0722	2.6000	27.5997	1892.88	0.0129	3.4087	0.0851	0.0967	3.3584	38.3081	2762.69	0.0193

Vehicle Type	Year 4 VOC	Year 4 $PM_{2.5}$	Year 4 PM_{10}	Year 4 NO_x	Year 4 CO	Year 4 CO_2 (7)	Year 4 SO_2	Year 5 VOC	Year 5 $PM_{2.5}$	Year 5 PM_{10}	Year 5 NO_x	Year 5 CO	Year 5 CO_2 (7)	Year 5 SO_2	Year 6 VOC	Year 6 $PM_{2.5}$	Year 6 PM_{10}	Year 6 NO_x	Year 6 CO	Year 6 CO_2 (7)	Year 6 SO_2
Passenger Cars	1.3426	0.0348	0.0387	1.0601	14.7994	#######	0.0077	0.8125	0.0206	0.0232	0.6139	9.3271	760.502	0.0052	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	1.7140	0.0426	0.0503	1.8378	20.7462	1512.60	0.0116	1.0292	0.0258	0.0310	1.0705	12.8300	979.77	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
Total Annual Emissions from Worker Vehicles	3.0566	0.0774	0.0890	2.8980	35.5455	2686.55	0.0193	1.8417	0.0464	0.0542	1.6844	22.1571	1740.27	0.0129	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000

Notes [ ]:

1. Kalamazoo County emission Factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model.
   The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2016 emission factors are used for Year 1, 2017 for Year 2, 2018 for Year 3, 2019 for Year 4, 2020 for Year 5, and 2020 for Year 6.
2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling within the non-attainment/maintenance area to and from the FCTC Site 2.
4. It is assumed that each month contains 26 work days, working 6 days a week over an average year of 365 days.
5. Trips/Day are based on monthly project estimates for the expected distribution of workers averaged over each year of the expected construction schedule. The analysis uses one-hundred
   workers during months 1-6 starting in Oct of Year 1, 400 construction workers during months 7-18 starting in April of Year 2, 600 workers during months 19-42 April of Year 3, and 400 construciton workers during months 43-54 starting in April of Year 5.
6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 2 On-Road Haul/Delivery Truck Estimated Emissions

Baseline Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks duirng Construciton

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.698	0.272	0.295	7.350	2.369	1538.27	0.014	0.639	0.238	0.259	6.682	2.181	1523.74	0.013	0.583	0.206	0.224	6.048	2.008	1509.30	0.013

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.535	0.179	0.195	5.489	1.858	1495.96	0.013	0.492	0.156	0.170	4.988	1.726	1483.52	0.013	0.492	0.156	0.170	4.988	1.726	1483.52	0.013

Estimated Annual Air Emissions: Oct. - Dec for Year 1, Jan.-Mar. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]					
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
HDDV	20	78	78	78	90	90	90	90	90	90

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	0.1080	0.0421	0.0457	1.1375	0.3666	#######	0.0022	0.0989	0.0368	0.0401	1.0341	0.3375	213.933	0.0020	0.0902	0.0319	0.0347	0.9360	0.3108	211.905	0.0020
Total Annual Emissions from Worker Vehicles	0.1080	0.0421	0.0457	1.1375	0.3666	#######	0.0022	0.0989	0.0368	0.0401	1.0341	0.3375	213.93	0.0020	0.0902	0.0319	0.0347	0.9360	0.3108	211.91	0.0020

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	0.0828	0.0277	0.0302	0.8495	0.2876	210.032	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	#######	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	#######	0.0020
Total Annual Emissions from Worker Vehicles	0.0828	0.0277	0.0302	0.8495	0.2876	210.03	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	208.29	0.0020	0.0761	0.0241	0.0263	0.7720	0.2671	208.29	0.0020

Estimated Annual Air Emissions: Apr.-Dec. Years 2-6 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]					
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
HDDV	20	234	234	234	0	90	90	90	90	0

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.2967	0.1105	0.1203	3.1024	1.0126	641.799	0.0060	0.2707	0.0956	0.1040	2.8080	0.9323	635.72	0.0060
Total Annual Emissions from Worker Vehicles	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.2967	0.1105	0.1203	3.1024	1.0126	641.80	0.0060	0.2707	0.0956	0.1040	2.8080	0.9323	635.72	0.0060

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	0.2484	0.0831	0.0905	2.5485	0.8627	630.096	0.0060	0.2284	0.0724	0.0789	2.3159	0.8014	624.857	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Total Annual Emissions from Worker Vehicles	0.2484	0.0831	0.0905	2.5485	0.8627	630.10	0.0060	0.2284	0.0724	0.0789	2.3159	0.8014	624.857	0.0060	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000

Notes [ ]:

1. Kalamazoo County emission Factors for Heavy Duty Diesel Vehicles (HDDV) are from USAF 's ACAM model.
   The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2016 emission factors are used for Year 1, 2017 for Year 2, 2018 for Year 3, 2019 for Year 4, 2020 for Year 5, and 2020 for Year 6.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the FCTC Site 2 site to an offsite dump location.
4. It is assumed that each month contains 26 work days, working 6 days a week over an average year of 365 days.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are assumed for all years of construction. It is assumed that the on road haul/delivery trucks wil be used to removed construction waste from the site, deliver construction materials to the site, and other types of activities during construction.
6. Tree clearing is expected start in October of Year 1 to March of Year 2. Site preparation is expected to take place starting in April of Year 2 through March of Year 3. Heavy construction is expected to start in April of Year 3 through March of Year 5. Buildout is expected to start in April of Year 5 through March of Year 6.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 2 Total Emissions

Baseline Schedule

FCTC Site 2 Estimated Air Emissions During Construction

Year 1

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	0.23	0.25	0.11	0.59
NO_X	1.59	0.30	1.14	3.03
SO_X	0.003	0.003	0.002	0.009
$PM_{2.5}$	0.09	0.01	0.04	0.14
PM_{10}	0.09	0.01	0.05	0.14
CO	1.12	2.65	0.37	4.13
CO_2 [4]	221.25	161.91	215.97	599.13

Year 2

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	3.75	2.76	0.40	6.91
NO_X	25.07	2.82	4.14	32.02
SO_X	0.044	0.014	0.008	0.066
$PM_{2.5}$	1.39	0.07	0.15	1.60
PM_{10}	3,890.47	0.08	0.16	3,890.70
CO	19.42	29.90	1.35	50.67
CO_2 [4]	3,762.13	2,050.62	855.73	6,668.48

Year 3

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	4.83	4.17	0.36	9.35
NO_X	31.80	4.10	3.74	39.65
SO_X	0.055	0.024	0.008	0.087
$PM_{2.5}$	1.75	0.10	0.13	1.98
PM_{10}	1,298.11	0.12	0.14	1,298.36
CO	24.15	46.82	1.24	72.21
CO_2 [4]	4,683.19	3,376.62	847.62	8,907.43

Year 4

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	4.93	4.08	0.33	9.34
NO_X	32.14	3.86	3.40	39.40
SO_X	0.055	0.026	0.008	0.089
$PM_{2.5}$	1.76	0.10	0.11	1.98
PM_{10}	1.76	0.12	0.12	2.00
CO	24.21	47.39	1.15	72.75
CO_2 [4]	4,689.18	3,582.06	840.13	9,111.37

Year 5

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	1.69	2.76	0.30	4.76
NO_X	11.28	2.53	3.09	16.90
SO_X	0.028	0.019	0.008	0.055
$PM_{2.5}$	0.53	0.07	0.10	0.69
PM_{10}	0.53	0.08	0.11	0.71
CO	10.48	33.24	1.07	44.78
CO_2 [4]	2,403.19	2,610.41	833.14	5,846.74

Year 6

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
VOC	0.16	0.61	0.08	0.85
NO_X	1.10	0.56	0.77	2.43
SO_X	0.005	0.004	0.002	0.011
$PM_{2.5}$	0.03	0.02	0.02	0.07
PM_{10}	0.03	0.02	0.03	0.07
CO	1.49	7.39	0.27	9.14
CO_2 [4]	411.85	580.09	208.29	1,200.23

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculted in the tabs on this spreadsheet using emission factors from ACAM 5.02 and CO2e is given in metric tons.

Construction – Expedited Schedule

FCTC Site 1

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FCTC Site 1 Construction CO_2 Emission Calculations

Expedited Schedule

Annual Emission Factors		Year 2	Year 3	Year 4
		Emission Factors [1] (lb/hr)		
Activity	**Construction Equipment Name**	**CO2**	**CO2**	**CO2**
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.56	122.56	122.56
	Rubber Tire Loaders Composite	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.57	119.57	119.57
	Graders Composite	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other Material Handling Equipment Composite	141.19	141.19	141.19
	Rollers Composite	67.046	67.046	67.046
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.87	164.87	164.87
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74
	Other Construction Equipment Composite	122.50	122.50	122.50
	Rollers Composite	67.042	67.042	67.042

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.02 program.

Annual Estimated Emissions							Year 2	Year 3	Year 4
Activity	**Construction Equipment Name[1]**	**Number of Equipment Pieces[2]**	**Year 2 Days/yr[3]**	**Year 3 Days/yr[3]**	**Year 4 Days/yr[3]**	**Equipment Use (hpd)[4]**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**
Tree Clearing (Months 4-7)	Air Compressors Composite	3	120	0	0	6.28	65.228	0.000	0.000
	Crawler Tractors Composite	4	120	0	0	6.08	150.923	0.000	0.000
	Crushing/Proc Equipment Composite	2	120	0	0	6.42	92.464	0.000	0.000
	Excavators Composite	4	120	0	0	12.44	323.882	0.000	0.000
	Off-Highway Trucks	1	120	0	0	0.02	0.283	0.000	0.000
	Other Construction Equipment Composite	1	120	0	0	0.60	4.003	0.000	0.000
	Rubber Tire Loaders Composite	2	120	0	0	3.72	43.984	0.000	0.000
Site Prep (Months 8-14)	Air Compressors Composite	3	214	0	0	6.28	116.323	0.000	0.000
	Bore/Drill Rigs Composite	2	214	0	0	0.84	26.891	0.000	0.000
	Crawler Tractors Composite	7	214	0	0	6.08	471.004	0.000	0.000
	Crushing/Proc Equipment Composite	1	214	0	0	6.42	82.447	0.000	0.000
	Excavators Composite	21	214	0	0	12.44	3032.089	0.000	0.000
	Graders Composite	1	214	0	0	11.18	144.053	0.000	0.000
	Off-Highway Trucks	1	214	0	0	0.02	0.505	0.000	0.000
	Other Construction Equipment Composite	1	214	0	0	0.60	7.137	0.000	0.000
	Other Material Handling Equipment Composite	3	214	0	0	6.48	266.428	0.000	0.000
	Rollers Composite	16	214	0	0	17.14	1784.776	0.000	0.000
	Rubber Tire Loaders Composite	2	214	0	0	3.72	78.437	0.000	0.000
	Scrapers Composite	1	214	0	0	17.32	441.290	0.000	0.000
	Trenchers Composite	1	214	0	0	4.36	24.849	0.000	0.000
Construction (Months 15-29)	Aerial Lifts Composite	4	31	365	59	6.56	12.811	150.840	24.382
	Air Compressors Composite	5	31	365	59	12.62	56.437	664.498	107.412
	Bore/Drill Rigs Composite	1	31	365	59	4.50	10.434	122.847	19.858
	Concrete and Mortar Mixers	1	31	365	59	1.14	0.116	1.368	0.221
	Concrete/Industrial Saws Composite	1	31	365	59	2.26	1.858	21.875	3.536
	Cranes	21	31	365	59	4.30	163.314	1922.894	310.824
	Crawler Tractors Composite	11	31	365	59	8.32	146.719	1727.500	279.240
	Excavators Composite	1	31	365	59	0.94	1.580	18.608	3.008
	Generator Sets Composite	1	31	365	59	4.78	4.099	48.268	7.802
	Other Construction Equipment Composite	11	31	365	59	3.74	70.888	834.644	134.915
	Other General Industrial Equipment Composite	1	31	365	59	4.78	10.232	120.472	19.474
	Paving Equipment Composite	8	31	365	59	3.24	25.127	295.846	47.822
	Plate Compactors Composite	4	31	365	59	3.78	0.917	10.799	1.746
	Pumps Composite	12	31	365	59	12.10	101.281	1192.504	192.761
	Rubber Tire Loaders Composite	16	31	365	59	6.96	170.070	2002.434	323.681
	Surfacing Equipment Composite	1	31	365	59	3.54	8.261	97.267	15.723
	Tractors/Loaders/Backhoes Composite	2	31	365	59	1.72	3.231	38.043	6.149
	Trenchers Composite	1	31	365	59	0.10	0.083	0.972	0.157
	Welders Composite	22	31	365	59	17.76	140.659	1656.146	267.706
1-Mo Construction (Month 23)	Paving Composite	5	0	31	0	9.18	0.000	44.495	0.000
Buildout (Months 30-36)	Bore/Drill Rigs Composite	8	0	0	214	15.84	0.000	0.000	2027.995
	Crushing/Proc Equipment Composite	1	0	0	214	1.24	0.000	0.000	15.924
	Graders Composite	1	0	0	214	2.62	0.000	0.000	33.758
	Other Construction Equipment Composite	2	0	0	214	0.28	0.000	0.000	6.659
	Rollers Composite	6	0	0	214	4.50	0.000	0.000	175.708
							Year 2	**Year 3**	**Year 4**
Total CO2 Tons Emissions from Construction Equipment							**8,085.11**	**10,972.32**	**4,026.46**

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.

2. The analysis assumes that construction will occur every day of the month.

3. Total days per year was determined by the construction schedule working 7 days a week per the EIS construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1.

4. The number of equipment pieces assumes the same quantities used in the baseline construction schedule, but the hours per day are double the hours used in the baseline construction schedule.

FCTC Site 1 Construction Worker Vehicle Estimated Emissions

Expedited Schedule

Air Emissions Estimate for Worker Vehicles during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.429	0.011	0.013	0.372	4.342	351.890	0.002	0.385	0.010	0.011	0.319	4.071	343.442	0.002	0.347	0.009	0.010	0.274	3.825	334.459	0.002
Light-Duty Trucks	0.559	0.013	0.015	0.636	6.358	457.034	0.003	0.496	0.012	0.014	0.549	5.830	443.649	0.003	0.443	0.011	0.013	0.475	5.362	430.939	0.003

Estimated Annual Air Emissions: Jan - Apr. Year 2 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	120	0	0	100	0	0	0.2837	0.0073	0.0086	0.2460	2.8717	211.134	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	50	120	0	0	100	0	0	0.3697	0.0086	0.0099	0.4206	4.2051	274.22	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
		Total Annual Emissions from Worker Vehicles						**0.6535**	**0.0159**	**0.0185**	**0.6667**	**7.0768**	**485.35**	**0.0033**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**

Estimated Annual Air Emissions: May - Nov. Year 2, Mar - Sep. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	214	0	214	400	0	400	2.0240	0.0519	0.0613	1.7551	20.4851	1506.09	0.0094	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.6371	0.0425	0.0472	1.2927	18.0459	1431.48	0.0094
Light-Duty Trucks	50	214	0	214	400	0	400	2.6373	0.0613	0.0708	3.0006	29.9964	1956.11	0.0142	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	2.0900	0.0519	0.0613	2.2410	25.2973	1844.42	0.0142
		Total Annual Emissions from Worker Vehicles						**4.6613**	**0.1132**	**0.1321**	**4.7556**	**50.4815**	**3462.19**	**0.0236**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**3.7271**	**0.0944**	**0.1085**	**3.5337**	**43.3433**	**3275.90**	**0.0236**

Estimated Annual Air Emissions: Dec. Year 2 - Feb. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	31	365	59	600	600	600	0.4398	0.0113	0.0133	0.3814	4.4512	327.258	0.0021	4.6471	0.1207	0.1328	3.8504	49.1382	3760.69	0.0241	0.6770	0.0176	0.0195	0.5346	7.4629	591.99	0.0039
Light-Duty Trucks	50	31	365	59	600	600	600	0.5731	0.0133	0.0154	0.6520	6.5179	425.04	0.0031	5.9869	0.1448	0.1690	6.6266	70.3699	4857.96	0.0362	0.8643	0.0215	0.0254	0.9268	10.4618	762.76	0.0059
		Total Annual Emissions from Worker Vehicles						**1.0128**	**0.0246**	**0.0287**	**1.0334**	**10.9691**	**752.30**	**0.0051**	**10.6339**	**0.2655**	**0.3018**	**10.4770**	**119.51**	**8618.65**	**0.0604**	**1.5414**	**0.0390**	**0.0449**	**1.4614**	**17.925**	**1354.75**	**0.0098**

Notes [ ]:

1. Kalamazoo and Calhoun County emission Factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4. The expedited construction schedule will occur during Years 2-4.

2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.

3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling to and from the FCTC Site 1.
4. It is assumed that workers will work seven days per week with the expedited schedule.

5. Trips/Day are based on monthly project estimates for the expected distribution of workers averaged over each year of the expected construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1. The analysis uses 200 workers during months 4-7 starting in January of Year 2, 800 construction workers during months 8-14 starting in May of Year 2, 1200 workers during months 15-29 starting December of Year 2, and 800 construction workers during months 30-36 starting in March of Year 4.
6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 1 On-Road Haul/Delivery Truck Estimated Emissions

Expedited Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.639	0.238	0.259	6.682	2.181	1523.74	0.013	0.583	0.206	0.224	6.048	2.008	1509.30	0.013	0.535	0.179	0.195	5.489	1.858	1495.96	0.013

Estimated Annual Air Emissions (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	20	365	365	273	90	90	90	0.4628	0.1724	0.1876	4.8392	1.5795	#######	0.0094	0.4222	0.1492	0.1622	4.3801	1.4542	991.607	0.0094	0.2898	0.0970	0.1056	2.9733	1.0064	735.112	0.0070
		Total Annual Emissions from Haul/Delivery Trucks						**0.4628**	**0.1724**	**0.1876**	**4.8392**	**1.5795**	**1001.10**	**0.0094**	**0.4222**	**0.1492**	**0.1622**	**4.3801**	**1.4542**	**991.61**	**0.0094**	**0.2898**	**0.0970**	**0.1056**	**2.9733**	**1.0064**	**735.11**	**0.0070**

Notes [ ]:

1. Kalamazoo and Calhoun County emission Factors for Heavy Duty Diesel Vehicles (HDDV) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the FCTC Site 1 site to an off base location.
4. It is assumed that workers will work seven days per week with the expedited schedule.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are assumed for all years of construction. It is assumed that the on road haul/delivery trucks will be used to removed construction waste from the site, remove cut from or deliver fill to the site, deliver construction materials to the site, and other types of activities during construction.
6. It is assumed that the final design would be completed and required permits would be obtained in Year 1. Tree clearing is expected to start in January of Year 2 to April of Year 2. Site preparation is expected to take place starting in May of Year 2 through November of Year 2. Heavy construction is expected to start in December of Year 2 through February of Year 4. Buildout is expected to start in March of Year 4 through September of Year 4.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 1 Total Emissions

Expedited Schedule

FCTC Site 1 Estimated Air Emissions During Construction

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
Year 2				
VOC	7.71	6.33	0.46	14.50
NO_X	51.36	6.46	4.84	62.66
SO_X	1.409	0.032	0.009	1.450
$PM_{2.5}$	2.84	0.15	0.17	3.17
PM_{10}	3,351.64	0.18	0.19	3,352.01
CO	39.55	68.53	1.58	109.66
CO_2e (4)	8,085.11	4,699.85	1,001.10	13,786.06
Year 3				
VOC	13.80	10.63	0.42	24.85
NO_X	90.65	10.48	4.38	105.50
SO_X	15.980	0.060	0.009	16.050
$PM_{2.5}$	5.10	0.27	0.15	5.51
PM_{10}	1,679.50	0.30	0.16	1,679.96
CO	65.38	119.51	1.45	186.34
CO_2e (4)	10,972.32	8,618.65	991.61	20,582.57
Year 4				
VOC	2.54	5.27	0.29	8.10
NO_X	17.17	5.00	2.97	25.13
SO_X	2.679	0.033	0.007	2.719
$PM_{2.5}$	0.82	0.13	0.10	1.05
PM_{10}	0.82	0.15	0.11	1.08
CO	15.09	61.27	1.01	77.36
CO_2e (4)	4,026.46	4,630.66	735.11	9,392.23

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculated in the tabs on this spreadsheet using emission factors from ACAM 5.02 and is given in metric tons.

Construction – Expedited Schedule

FCTC Site 2

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FCTC Site 2 Construction CO_2 Emission Calculations

Expedited Schedule

Annual Emission Factors		Year 2	Year 3	Year 4
		Emission Factors [1] (lb/hr)		
Activity	Construction Equipment Name	CO2	CO2	CO2
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54
	Rubber Tire Loaders Composite	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.57	119.57	119.57
	Graders Composite	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other Material Handling Equipment Composite	141.19	141.19	141.19
	Rollers Composite	67.046	67.046	67.046
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.87	164.87	164.87
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74
	Other Construction Equipment Composite	122.50	122.50	122.50
	Rollers Composite	67.042	67.042	67.042

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.02 program.

Annual Estimated Emissions							Year 2	Year 3	Year 4
Activity	Construction Equipment Name [1]	Number of Equipment Pieces [2]	Year 2 Days/yr [3]	Year 3 Days/yr [3]	Year 4 Days/yr [3]	Equipment Use (hpd) [4]	Metric Tons CO2	Metric Tons CO2	Metric Tons CO2
Tree Clearing (Months 4-7)	Air Compressors Composite	3	120	0	0	6.28	65.228	0.000	0.000
	Crawler Tractors Composite	4	120	0	0	6.08	150.923	0.000	0.000
	Crushing/Proc Equipment Composite	2	120	0	0	6.42	92.464	0.000	0.000
	Excavators Composite	4	120	0	0	12.44	323.882	0.000	0.000
	Off-Highway Trucks	1	120	0	0	0.02	0.283	0.000	0.000
	Other Construction Equipment Composite	1	120	0	0	0.60	4.002	0.000	0.000
	Rubber Tire Loaders Composite	2	120	0	0	3.72	43.984	0.000	0.000
Site Prep (Months 8-14)	Air Compressors Composite	3	214	0	0	6.28	116.323	0.000	0.000
	Bore/Drill Rigs Composite	2	214	0	0	0.84	26.891	0.000	0.000
	Crawler Tractors Composite	7	214	0	0	6.08	471.004	0.000	0.000
	Crushing/Proc Equipment Composite	1	214	0	0	6.42	82.447	0.000	0.000
	Excavators Composite	21	214	0	0	12.44	3032.089	0.000	0.000
	Graders Composite	1	214	0	0	11.18	144.053	0.000	0.000
	Off-Highway Trucks	1	214	0	0	0.02	0.505	0.000	0.000
	Other Construction Equipment Composite	1	214	0	0	0.60	7.137	0.000	0.000
	Other Material Handling Equipment Composite	3	214	0	0	6.48	266.428	0.000	0.000
	Rollers Composite	16	214	0	0	17.14	1784.776	0.000	0.000
	Rubber Tire Loaders Composite	2	214	0	0	3.72	78.437	0.000	0.000
	Scrapers Composite	1	214	0	0	17.32	441.290	0.000	0.000
	Trenchers Composite	1	214	0	0	4.36	24.849	0.000	0.000
Construction (Months 15-29)	Aerial Lifts Composite	4	31	365	59	6.56	12.811	150.840	24.382
	Air Compressors Composite	5	31	365	59	12.62	56.437	664.498	107.412
	Bore/Drill Rigs Composite	1	31	365	59	4.50	10.434	122.847	19.858
	Concrete and Mortar Mixers	1	31	365	59	1.14	0.116	1.368	0.221
	Concrete/Industrial Saws Composite	1	31	365	59	2.26	1.858	21.875	3.536
	Cranes	21	31	365	59	4.30	163.314	1922.894	310.824
	Crawler Tractors Composite	11	31	365	59	8.32	146.719	1727.500	279.240
	Excavators Composite	1	31	365	59	0.94	1.580	18.608	3.008
	Generator Sets Composite	1	31	365	59	4.78	4.099	48.268	7.802
	Other Construction Equipment Composite	11	31	365	59	3.74	70.888	834.644	134.915
	Other General Industrial Equipment Composite	1	31	365	59	4.78	10.232	120.472	19.474
	Paving Equipment Composite	8	31	365	59	3.24	25.127	295.846	47.822
	Plate Compactors Composite	4	31	365	59	3.78	0.917	10.799	1.746
	Pumps Composite	12	31	365	59	12.10	101.281	1192.504	192.761
	Rubber Tire Loaders Composite	16	31	365	59	6.96	170.070	2002.434	323.681
	Surfacing Equipment Composite	1	31	365	59	3.54	8.261	97.267	15.723
	Tractors/Loaders/Backhoes Composite	2	31	365	59	1.72	3.231	38.043	6.149
	Trenchers Composite	1	31	365	59	0.10	0.083	0.972	0.157
	Welders Composite	22	31	365	59	17.76	140.659	1656.146	267.706
1-Mo Construction (Month 23)	Paving Composite	5	0	31	0	9.18	0.000	44.495	0.000
Buildout (Months 30-36)	Bore/Drill Rigs Composite	8	0	0	214	15.84	0.000	0.000	2027.995
	Crushing/Proc Equipment Composite	1	0	0	214	1.24	0.000	0.000	15.924
	Graders Composite	1	0	0	214	2.62	0.000	0.000	33.758
	Other Construction Equipment Composite	2	0	0	214	0.28	0.000	0.000	6.659
	Rollers Composite	6	0	0	214	4.50	0.000	0.000	175.708
							Year 2	Year 3	Year 4
Total CO2 Tons Emissions from Construction Equipment							8,085.11	10,972.32	4,026.46

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.

2. The analysis assumes that construction will occur every day of the month.

3. Total days per year was determined by the construction schedule working 7 days a week per the EIS construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1.

4. The number of equipment pieces assumes the same quantities used in the baseline construction schedule, but the hours per day are double the hours used in the baseline construction schedule.

FCTC Site 2 Construction Worker Vehicle Estimated Emissions

Expedited Schedule

Air Emissions Estimate for Worker Vehicles during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.429	0.011	0.013	0.372	4.342	351.890	0.002	0.385	0.010	0.011	0.319	4.071	343.442	0.002	0.347	0.009	0.010	0.274	3.825	334.459	0.002
Light-Duty Trucks	0.559	0.013	0.015	0.636	6.358	457.034	0.003	0.496	0.012	0.014	0.549	5.830	443.649	0.003	0.443	0.011	0.013	0.475	5.362	430.939	0.003

Estimated Annual Air Emissions: Jan - Apr. Year 2 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day[5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2
Passenger Cars	50	120	0	0	100	0	0	0.2837	0.0073	0.0086	0.2460	2.8717	211.134	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	50	120	0	0	100	0	0	0.3697	0.0086	0.0099	0.4206	4.2051	274.22	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
		Total Annual Emissions from Worker Vehicles						**0.6535**	**0.0159**	**0.0185**	**0.6667**	**7.0768**	**485.35**	**0.0033**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**

Estimated Annual Air Emissions: May - Nov. Year 2, Mar - Sep. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day[5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2
Passenger Cars	50	214	0	214	400	0	400	2.0240	0.0519	0.0613	1.7551	20.4851	1506.09	0.0094	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.6371	0.0425	0.0472	1.2927	18.0459	1431.48	0.0094
Light-Duty Trucks	50	214	0	214	400	0	400	2.6373	0.0613	0.0708	3.0006	29.9964	1956.11	0.0142	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	2.0900	0.0519	0.0613	2.2410	25.2973	1844.42	0.0142
		Total Annual Emissions from Worker Vehicles						**4.6613**	**0.1132**	**0.1321**	**4.7556**	**50.4815**	**3462.19**	**0.0236**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**3.7271**	**0.0944**	**0.1085**	**3.5337**	**43.3433**	**3275.90**	**0.0236**

Estimated Annual Air Emissions: Dec. Year 2 - Feb. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day[5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 (7)	SO_2
Passenger Cars	50	31	365	59	600	600	600	0.4398	0.0113	0.0133	0.3814	4.4512	327.258	0.0021	4.6471	0.1207	0.1328	3.8504	49.1382	3760.69	0.0241	0.6770	0.0176	0.0195	0.5346	7.4629	591.99	0.0039
Light-Duty Trucks	50	31	365	59	600	600	600	0.5731	0.0133	0.0154	0.6520	6.5179	425.04	0.0031	5.9869	0.1448	0.1690	6.6266	70.3699	4857.96	0.0362	0.8643	0.0215	0.0254	0.9268	10.4618	762.76	0.0059
		Total Annual Emissions from Worker Vehicles						**1.0128**	**0.0246**	**0.0287**	**1.0334**	**10.9691**	**752.30**	**0.0051**	**10.6339**	**0.2655**	**0.3018**	**10.4770**	**119.51**	**8618.65**	**0.0604**	**1.5414**	**0.0390**	**0.0449**	**1.4614**	**17.925**	**1354.75**	**0.0098**

Notes [ ]:

1. Kalamazoo County emission factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4. The expedited construction schedule will occur during Years 2-4.

2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.

3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling to and from the FCTC Site 2.
4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.

5. Trips/Day are based on monthly project estimates for the expected distribution of workers averaged over each year of the expected construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1. The analysis uses 200 workers during months 4-7 starting in January of Year 2, 800 construction workers during months 8-14 starting in May of Year 2, 1200 workers during months 15-29 starting December of Year 2, and 800 construction workers during months 30-36 starting in March of Year 4.
6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 2 On-Road Haul/Delivery Truck Estimated Emissions

Expedited Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.639	0.238	0.259	6.682	2.181	1523.74	0.013	0.583	0.206	0.224	6.048	2.008	1509.30	0.013	0.535	0.179	0.195	5.489	1.858	1495.96	0.013

Estimated Annual Air Emissions (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	20	365	365	273	90	90	90	0.4628	0.1724	0.1876	4.8392	1.5795	#######	0.0094	0.4222	0.1492	0.1622	4.3801	1.4542	991.607	0.0094	0.2898	0.0970	0.1056	2.9733	1.0064	735.112	0.0070
		Total Annual Emissions from Haul/Delivery Trucks						**0.4628**	**0.1724**	**0.1876**	**4.8392**	**1.5795**	**1001.10**	**0.0094**	**0.4222**	**0.1492**	**0.1622**	**4.3801**	**1.4542**	**991.61**	**0.0094**	**0.2898**	**0.0970**	**0.1056**	**2.9733**	**1.0064**	**735.11**	**0.0070**

Notes [ ]:

1. Kalamazoo County emission factors for Heavy Duty Diesel Vehicles (HDDV) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the FCTC Site 2 site to an off base location.
4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are assumed for all years of construction. It is assumed that the on road haul/delivery trucks will be used to removed construction waste from the site, remove cut from or deliver fill to the site, deliver construction materials to the site, and other types of activities during construction.
6. It is assumed that the final design would be completed and required permits would be obtained in Year 1. Tree clearing is expected to start in January of Year 2 to April of Year 2. Site preparation is expected to take place starting in May of Year 2 through November of Year 2. Heavy construction is expected to start in December of Year 2 through February of Year 4. Buildout is expected to start in March of Year 4 through September of Year 4.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 2 Total Emissions

Expedited Schedule

FCTC Site 2 Estimated Air Emissions During Construction

Pollutant	Construction Equipment Emissions (1) (ton/yr)	Worker Vehicle Emissions (2) (ton/yr)	On-Road Haul/Delivery Truck Emissions (3) (ton/yr)	TOTAL Annual Emissions (ton/yr)
Year 2				
VOC	7.71	6.33	0.46	14.50
NO_X	51.36	6.46	4.84	62.66
SO_X	1.409	0.032	0.009	1.450
$PM_{2.5}$	2.84	0.15	0.17	3.17
PM_{10}	3,459.80	0.18	0.19	3,460.17
CO	39.55	68.53	1.58	109.66
CO_2e (4)	8,085.11	4,699.85	1,001.10	13,786.06
Year 3				
VOC	13.80	10.63	0.42	24.85
NO_X	90.65	10.48	4.38	105.50
SO_X	15.980	0.060	0.009	16.050
$PM_{2.5}$	5.10	0.27	0.15	5.51
PM_{10}	1,733.58	0.30	0.16	1,734.04
CO	65.38	119.51	1.45	186.34
CO_2e (4)	10,972.32	8,618.65	991.61	20,582.57
Year 4				
VOC	2.54	5.27	0.29	8.10
NO_X	17.17	5.00	2.97	25.13
SO_X	2.679	0.033	0.007	2.719
$PM_{2.5}$	0.82	0.13	0.10	1.05
PM_{10}	0.82	0.15	0.11	1.08
CO	15.09	61.27	1.01	77.36
CO_2e (4)	4,026.46	4,630.66	735.11	9,392.23

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculated in the tabs on this spreadsheet using emission factors from ACAM 5.02 and is given in metric tons.

Operation – Baseline Schedule

FCTC Sites 1 and 2

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CONUS CIS

FCTC Sites 1 and 2

Baseline Schedule

Air Emissions Estimate for Power Plant Generators

Basis:

Number of Units	4	
Fuel	Diesel Fuel Oil	
Power Rating	3,000	kW
Heat Input	28.87	mmBtu/hr
Heating Value of Fuel	137,000	Btu/gal [2]
Fuel Burn Rate	211	gal/hr [1]
Hours of Operation	500	hours per year
Density of Fuel	7.05	lb/gal [2]
Sulfur Content of Fuel	0.0015	% [3]

Global Warming Potentials [4]

CO_2	1
CH_4	25
N_2O	298

Pollutant	Mass Emission Rate				Annual Emissions (tpy)	
	g/kw-hr	lb/mmBtu	Notes	lb/hr	Year 6	Year 7
CO	3.50		[8]	23.15	17.36	23.15
NO_X	6.40		[8]	42.33	31.75	42.33
PM	0.20		[8]	1.32	0.99	1.32
PM_{10}	0.20		[5]	1.32	0.99	1.32
$PM_{2.5}$	0.20		[5]	1.32	0.99	1.32
SO_2	0.0067		[6]	0.045	0.033	0.045
VOC	6.40		[8,9]	42.33	31.75	42.33
GHG-Mass	--	--	[8]	4,707	3,530	4,707
CO_2	--	1.63E+02	[10]	4,706.70	3,530	4,707
CH_4	--	6.61E-03	[10]	0.19	0.14	0.19
N_2O	--	1.32E-03	[10]	3.82E-02	0.03	0.04
GHG-CO2e	--		[7]	4,723	3,213	4,284
CO_2	--		[4]	4,707	3,202	4,270
CH_4	--		[4]	4.77	3.25	4.33
N_2O	--		[4]	11.4	7.74	10.32

Notes [ ]:

1. Based on manufacturer's specifications for Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum power rating.
2. Based on diesel fuel characteristics listed in Reference 1.
3. Based on the requirements of 40 CFR Part 63, Subpart ZZZZ and 40 CFR Part 80.510(b).
4. CO_2 equivalents (CO_2e) provided in metric tons based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
5. It is assumed that the PM_{10} and $PM_{2.5}$ emission factors are the same as PM.
6. Assumed all sulfur in the fuel is converted to SO_2.
7. The GHG emissions is the sum of all applicable GHG pollutants.
8. Emission limits for Tier II engine manufactured after 2010 and >900 kW - 40 CFR §89.112(a), Table 1.
9. Emission limit provided by Tier II standards is for NO_X+NMHC. Engine VOC emissions were conservatively assumed to be equal to the entire emission limit of 6.4 g/kW-hr.
10. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

FCTC Sites 1 and 2

Baseline Schedule

Air Emissions Estimate for 7 MMBtu/hr Boilers

Basis:

Number of Boilers	1	
Fuel	Diesel Fuel Oil	

Boiler Information

Heat Input	7.0	MMBtu/hr [1]
Heating Value of Fuel	137,000	Btu/gal[2]
Fuel Burn Rate	51	gal/hr
Hours of Operation (Per Boiler)	8,760	hours per year
Annual Fuel Usage (Cumulative)	447,591	gal/year
Sulfur Content of Fuel	0.0015	%

Miscellaneous Data

Density of Fuel Oil	7.05	lb/gal[2]
SO_2 to SO_3 Conversion Rate	100	% by volume (assumed)
Molecular Weight of Sulfur	32	lb/lb-mol
Molecular Weight of Oxygen	16	lb/lb-mol
Molecular Weight of Hydrogen	1	lb/lb-mol

Global Warming Potentials [10]	
CO_2	1
CH_4	25
N_2O	298

Boiler Emissions Summary

Pollutant	Mass Emission Rate (per unit)				Annual Emissions (tpy)	
	(lb/gal)	(lb/MMBtu)	Notes	(lb/hr)	Year 6 [11]	Year 7 [12]
CO	0.005	0.036	[5]	0.26	0.84	1.12
NO_X	0.02	0.146	[5]	1.02	3.36	4.48
PM (total)	0.0033	0.0241	[2,3,5]	0.169	0.55	0.74
PM (filterable)	0.0020	0.0146	[2,3,5]	0.102	0.34	0.45
PM (condensable)	0.0013	0.0095	[2,3]	0.066	0.22	0.29
PM_{10}		0.012	[7]	0.08	0.28	0.37
$PM_{2.5}$		0.003	[7]	0.020	0.07	0.09
SO_2	2.12E-04	1.54E-03	[4]	1.08E-02	0.04	0.05
VOC	2.52E-04	1.84E-03	[8]	1.29E-02	0.04	0.06
GHG-Mass		--	[9]	1,141.43	3,749.61	4,999.48
CO_2	--	1.63E+02	[6]	1,141	3,749.42	4,999.23
CH_4	--	6.61E-03	[6]	4.63E-02	0.15	0.20
N_2O	--	1.32E-03	[6]	9.26E-03	0.03	0.04
GHG-CO2e	--	--	[9]	1,145	3,413.09	4,550.79
CO_2	--	--	[10]	1,141	3,401.42	4,535.23
CH_4	--	--	[10]	1.16	3.45	4.60
N_2O	--	--	[10]	2.76	8.22	10.96

Notes [ ]:

1. Based on preliminary vendor data.
2. Based on fuel characteristics listed in Reference 2.
3. Total particulate matter is the sum of filterable and condensable PM, given in AP-42 (Reference 1b).
4. Assumed all sulfur in the fuel is converted to SO_2.
5. Criteria pollutant emission factors obtained from AP-42 (Reference 1a) for boilers < 100 Million Btu/hr.
6. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.
7. Particle size distribution obtained from AP-42 (Reference 1c).
8. AP-42 includes VOCs within Total Organic Compounds (TOCs), which also includes semi-volatile organic compounds and condensable organic compounds (Reference 1d).
9. The GHG emissions is the sum of all applicable GHG pollutants.
10. CO_2 equivalents (CO_2e) based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
11. Emissions for Year 6 are based on operations beginning in April (9 months of the year).
12. Emissions for tons in Year 7 are based on operations for a full annual period.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Chapter 1 "External Combustion Sources", Section 1.3 "Fuel Oil Combustion". September 1999.
   a. Table 1.3-1 "Criteria Pollutant Emission Factors for Fuel Oil Combustion".
   b. Table 1.3-2 "Condensable Particulate Matter Emission Factors for Oil Combustion"
   c. Table 1.3-6 "Cumulative Particle Size Distribution and Size-Specific Emission Factors for Uncontrolled Industrial Boilers Firing Distillate Oil."
   d. Table 1.3-3 "Emission Factors for Total Organic Compounds (TOC), Methane, and Nonmethane TOC (NMTOC) From Uncontrolled Fuel Oil Combustion."
2. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

FCTC Sites 1 and 2

Baseline Schedule

Calculate Annual Fuel Usage for Fuel Storage Tanks During Operations

Fuel Tank Diameter [(1)] (ft)	Fuel Tank Length [(1)] (ft)	Type of Fuel Tank [(2)]	Fuel Tank Capacity [(2)] (gal)	Number of Tanks [(2)]	Number of RICE Engines	Hours Per Year of RICE Engines [(3)]	Fuel Consumption Rate [(4)] (gal/hr)	Annual Fuel Consumption (gal/yr)	Annual Tank Turnovers
5.42	9	Vertical	1,500	4	4	500	210.7	421,400	280.93
10	51	Horizontal	30,000	3	4	500	210.7	421,400	14.05

Notes [ ]:

1. The fuel tank diameter and length were estimated using the National Board Standards from Engineering Toolbox Website (http://www.engineeringtoolbox.com/fuel-oil-storage-tanks-dimensions-d_1585.html). These numbers are used as input into the USAF's ACAM model to estimate VOC emissions from the fuel storage tanks.
2. The potential fuel storage tank parameters (i.e., type, number, and capacity) are based on information contained in the potential CIS deployment's Section 2.3 of the EIS.
3. The emission anlayis for the backup RICE engines assumes that the engines will operate 500 hours or less per year.
4. Fuel consumption rates are based on the manufacturer's specifications for a Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum operating at maximum load.

CONUS CIS

FCTC Sites 1 and 2

Baseline Schedule

Air Emissions Estimate for Fuel Storage Tanks During Operations

Emission Activitiy	Estimated Annual Air Emissions (tons/year) [1]													
	Year 6							Year 7						
	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Fuel Storage Tanks	0.048	0	0	0	0	0	0	0.064	0	0	0	0	0	0

Notes [ ]:

1. The fuel storage tanks will emit VOC's during operations. The amount of VOC's emitted was estimated using the USAF's ACAM model (Version 5.02) using as input the dimensions of the tank and the amount of turnovers per year for each tank.

CONUS CIS

FCTC Sites 1 and 2

Baseline Schedule

Air Emissions Estimate for Worker Vehicles During Operations

Vehicle Type [1]	Trips/ Day [2]	Days/Year [3]		Miles/ Trip [4]	Emission Factor (g/mi) [5]							Estimated Annual Air Emissions (tons/year) [6] Year 6							Year 7						
		Year 6	Year 7		VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Passenger Car	425	275	365	50	0.315	3.616	0.009	0.008	0.238	325.00	0.002	2.03	23.29	0.06	0.05	1.53	1,899	0.01	2.69	30.92	0.08	0.07	2.03	2,521	0.02
Light Duty Truck	425	275	365	50	0.399	4.974	0.012	0.010	0.415	418.71	0.003	2.57	32.04	0.08	0.06	2.67	2,447	0.02	3.41	42.53	0.10	0.09	3.55	3247.58	0.03
										Total Annual Emission		4.60	55.33	0.14	0.12	4.21	4,346	0.032	6.10	73.44	0.18	0.15	5.58	5,768	0.043

Notes [ ]:

1. It is assumed that the fleet of worker vehicles will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
2. Trips per day is based on the maximum number of workers during operation of the potential CIS deployment as listed in Chapter 2 of the EIS. A maximum of 850 workers are expected daily which is split between the two vehicle types. The workers include military, civilian, and contractor support maintenance personnel.
3. Days per year assumes that the potential CIS deployment will require workers traveling to the site each day of the year. It is assumed that opearations will start during April of Year 6.
4. Total miles/trip is a roundtrip distance traveled by the worker vehicles to account for indirect emissions during operation of the potential CIS deployment.
5. The emission factors are from the United States Air Force (USAF) Air Conformity Applicability Model (ACAM). The ACAM model emission factors are derived from the United States Environmental Protection Agency (USEPA) Motor Vehicle Emission Simulator (MOVES) computer model. Emission Factors are for 2020 and are used for Years 6 and 7 (Years 2021 and 2022, respectively) to be conservative.
6. The total annual emissions for CO_2 emission is in units of metric tons per year. The total annual emissions for VOC, CO, PM_{10}, $PM_{2.5}$, NO_x, and SO_2 is provided in units of tons per year.

CONUS CIS

FCTC Sites 1 and 2

Baseline Schedule

Summary of Air Emissions Estimate During Operation of the Potential CIS Deployment

Pollutant	Estimated Annual Emissions (ton/year) [1]	
	Year 6	Year 7
NO_X	39.3	52.4
VOC	36.4	48.6
SO_2	0.10	0.13
$PM_{2.5}$	1.2	1.6
PM_{10}	1.4	1.9
CO	73.5	97.7
GHG - CO_{2e} Basis	10,972	14,604

Notes [ ]:

1. The air emissions of carbon dioxide equivalents (CO_2e) are provided in metric tons per year. The air emissions of criteria pollutants are provided in tons per year.

Operation – Expedited Schedule

FCTC Sites 1 and 2

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CONUS CIS

FCTC Sites 1 and 2

Expedited Schedule

Air Emissions Estimate for Power Plant Generators

Basis:

Number of Units	4	
Fuel	Diesel Fuel Oil	
Power Rating	3,000	kW
Heat Input	28.87	mmBtu/hr
Heating Value of Fuel	137,000	Btu/gal [2]
Fuel Burn Rate	211	gal/hr [1]
Hours of Operation	500	hours per year
Density of Fuel	7.05	lb/gal [2]
Sulfur Content of Fuel	0.0015	% [3]

Global Warming Potentials [4]

CO_2	1
CH_4	25
N_2O	298

Pollutant	Mass Emission Rate				Annual Emissions (tpy)	
	g/kw-hr	lb/mmBtu	Notes	lb/hr	Year 4	Year 5
CO	3.50		[8]	23.15	5.79	23.15
NO_X	6.40		[8]	42.33	10.58	42.33
PM	0.20		[8]	1.32	0.33	1.32
PM_{10}	0.20		[5]	1.32	0.33	1.32
$PM_{2.5}$	0.20		[5]	1.32	0.33	1.32
SO_2	0.0067		[6]	0.045	0.011	0.045
VOC	6.40		[8,9]	42.33	10.58	42.33
GHG-Mass	--	--	[8]	4,707	1,177	4,707
CO_2	--	1.63E+02	[10]	4,706.70	1,177	4,707
CH_4	--	6.61E-03	[10]	0.19	0.05	0.19
N_2O	--	1.32E-03	[10]	3.82E-02	0.01	0.04
GHG-CO2e	--		[7]	4,723	1,071	4,284
CO_2	--		[4]	4,707	1,067	4,270
CH_4	--		[4]	4.77	1.08	4.33
N_2O	--		[4]	11.4	2.58	10.32

Notes [ ]:

1. Based on manufacturer's specifications for Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum power rating.
2. Based on diesel fuel characteristics listed in Reference 1.
3. Based on the requirements of 40 CFR Part 63, Subpart ZZZZ and 40 CFR Part 80.510(b).
4. CO_2 equivalents (CO_2e) provided in metric tons based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
5. It is assumed that the PM_{10} and $PM_{2.5}$ emission factors are the same as PM.
6. Assumed all sulfur in the fuel is converted to SO_2.
7. The GHG emissions is the sum of all applicable GHG pollutants.
8. Emission limits for Tier II engine manufactured after 2010 and >900 kW - 40 CFR §89.112(a), Table 1.
9. Emission limit provided by Tier II standards is for NO_X+NMHC. Engine VOC emissions were conservatively assumed to be equal to the entire emission limit of 6.4 g/kW-hr.
10. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

FCTC Sites 1 and 2

Expedited Schedule

Air Emissions Estimate for 7 MMBtu/hr Boilers

Basis:

Number of Boilers	1	
Fuel	Diesel Fuel Oil	

Boiler Information

Heat Input	7.0	MMBtu/hr [1]
Heating Value of Fuel	137,000	Btu/gal[2]
Fuel Burn Rate	51	gal/hr
Hours of Operation (Per Boiler)	8,760	hours per year
Annual Fuel Usage (Cumulative)	447,591	gal/year
Sulfur Content of Fuel	0.0015	%

Miscellaneous Data

Density of Fuel Oil	7.05	lb/gal[2]
SO_2 to SO_3 Conversion Rate	100	% by volume (assumed)
Molecular Weight of Sulfur	32	lb/lb-mol
Molecular Weight of Oxygen	16	lb/lb-mol
Molecular Weight of Hydrogen	1	lb/lb-mol

Global Warming Potentials [10]	
CO_2	1
CH_4	25
N_2O	298

Boiler Emissions Summary

Pollutant	Mass Emission Rate (per unit)				Annual Emissions (tpy)	
	(lb/gal)	(lb/MMBtu)	Notes	(lb/hr)	Year 4 [11]	Year 5 [12]
CO	0.005	0.036	[5]	0.26	0.28	1.12
NO_X	0.02	0.146	[5]	1.02	1.12	4.48
PM (total)	0.0033	0.0241	[2,3,5]	0.169	0.18	0.74
PM (filterable)	0.0020	0.0146	[2,3,5]	0.102	0.11	0.45
PM (condensable)	0.0013	0.0095	[2,3]	0.066	0.07	0.29
PM_{10}		0.012	[7]	0.08	0.09	0.37
$PM_{2.5}$		0.003	[7]	0.020	0.02	0.09
SO_2	2.12E-04	1.54E-03	[4]	1.08E-02	0.012	0.047
VOC	2.52E-04	1.84E-03	[8]	1.29E-02	0.01	0.06
GHG-Mass		--	[9]	1,141.43	1,249.87	4,999.48
CO_2	--	1.63E+02	[6]	1,141	1,249.81	4,999.23
CH_4	--	6.61E-03	[6]	4.63E-02	0.05	0.20
N_2O	--	1.32E-03	[6]	9.26E-03	0.01	0.04
GHG-CO2e	--	--	[9]	1,145	1,137.70	4,550.79
CO_2	--	--	[10]	1,141	1,133.81	4,535.23
CH_4	--	--	[10]	1.16	1.15	4.60
N_2O	--	--	[10]	2.76	2.74	10.96

Notes [ ]:

1. Based on preliminary vendor data.
2. Based on fuel characteristics listed in Reference 2.
3. Total particulate matter is the sum of filterable and condensable PM, given in AP-42 (Reference 1b).
4. Assumed all sulfur in the fuel is converted to SO_2.
5. Criteria pollutant emission factors obtained from AP-42 (Reference 1a) for boilers < 100 Million Btu/hr.
6. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.
7. Particle size distribution obtained from AP-42 (Reference 1c).
8. AP-42 includes VOCs within Total Organic Compounds (TOCs), which also includes semi-volatile organic compounds and condensable organic compounds (Reference 1d).
9. The GHG emissions is the sum of all applicable GHG pollutants.
10. CO_2 equivalents (CO_2e) based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
11. Emissions for Year 4 are based on operations beginning in October (3 months of the year).
12. Emissions for tons in Year 5 are based on operations for a full annual period.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Chapter 1 "External Combustion Sources", Section 1.3 "Fuel Oil Combustion". September 1999.
   a. Table 1.3-1 "Criteria Pollutant Emission Factors for Fuel Oil Combustion".
   b. Table 1.3-2 "Condensable Particulate Matter Emission Factors for Oil Combustion"
   c. Table 1.3-6 "Cumulative Particle Size Distribution and Size-Specific Emission Factors for Uncontrolled Industrial Boilers Firing Distillate Oil."
   d. Table 1.3-3 "Emission Factors for Total Organic Compounds (TOC), Methane, and Nonmethane TOC (NMTOC) From Uncontrolled Fuel Oil Combustion."
2. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

FCTC Sites 1 and 2

Expedited Schedule

Calculate Annual Fuel Usage for Fuel Storage Tanks During Operations

Fuel Tank Diameter [(1)] (ft)	Fuel Tank Length [(1)] (ft)	Type of Fuel Tank [(2)]	Fuel Tank Capacity [(2)] (gal)	Number of Tanks [(2)]	Number of RICE Engines	Hours Per Year of RICE Engines [(3)]	Fuel Consumption Rate [(4)] (gal/hr)	Annual Fuel Consumption (gal/yr)	Annual Tank Turnovers
5.42	9	Vertical	1,500	4	4	500	210.7	421,400	280.93
10	51	Horizontal	30,000	3	4	500	210.7	421,400	14.05

Notes [ ]:

1. The fuel tank diameter and length were estimated using the National Board Standards from Engineering Toolbox Website (http://www.engineeringtoolbox.com/fuel-oil-storage-tanks-dimensions-d_1585.html). These numbers are used as input into the USAF's ACAM model to estimate VOC emissions from the fuel storage tanks.
2. The potential fuel storage tank parameters (i.e., type, number, and capacity) are based on information contained in the potential CIS deployment's Chapter 2.3 of the EIS.
3. The emission analysis for the backup RICE engines assumes that the engines will operate 500 hours or less per year.
4. Fuel consumption rates are based on the manufacturer's specifications for a Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum operating at maximum load.

CONUS CIS

FCTC Sites 1 and 2

Expedited Schedule

Air Emissions Estimate for Fuel Storage Tanks During Operations

Emission Activity	Estimated Annual Air Emissions (tons/year) [1]													
	Year 4							Year 5						
	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Fuel Storage Tanks	0.016	0	0	0	0	0	0	0.064	0	0	0	0	0	0

Notes [ ]:

1. The fuel storage tanks will emit VOC's during operations. The amount of VOC's emitted was estimated using the USAF's ACAM model (Version 5.02) using as input the dimensions of the tank and the amount of turnovers per year for each tank.

CONUS CIS

FCTC Sites 1 and 2

Expedited Schedule

Air Emissions Estimate for Worker Vehicles During Operations

Vehicle Type [1]	Trips/ Day [2]	Days/Year [3]		Miles/ Trip [4]	Emission Factor (g/mi) [5]							Estimated Annual Air Emissions (tons/year) [6] Year 4							Year 5						
		Year 4	Year 5		VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Passenger Car	425	92	365	50	0.347	3.825	0.010	0.009	0.274	334.46	0.002	0.75	8.24	0.02	0.02	0.59	654	0.004	2.97	32.70	0.09	0.08	2.34	2,594	0.017
Light Duty Truck	425	92	365	50	0.443	5.362	0.013	0.011	0.475	430.94	0.003	0.95	11.56	0.03	0.02	1.02	842	0.006	3.79	45.84	0.11	0.09	4.06	3342.47	0.026
											Total Annual Emission	1.70	19.80	0.05	0.04	1.61	1,496	0.011	6.75	78.55	0.20	0.17	6.40	5,937	0.043

Notes [ ]:

1. It is assumed that the fleet of worker vehicles will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
2. Trips per day is based on the maximum number of workers during operation of the potential CIS deployment as listed in Chapter 2 of the EIS. A maximum of 850 workers are expected daily which is split between the two vehicle types. The workers include military, civilian, and contractor support maintenance personnel.
3. Days per year assumes that the potential CIS deployment will require workers traveling to the site each day of the year. It is assumed that operations will start during October of Year 4.
4. Total miles/trip is a roundtrip distance traveled by the worker vehicles to account for indirect emissions during operation of the potential CIS deployment.
5. The emission factors are from the United States Air Force (USAF) Air Conformity Applicability Model (ACAM). The ACAM model emission factors are derived from the United States Environmental Protection Agency (USEPA) Motor Vehicle Emission Simulator (MOVES) computer model. Emission Factors are for 2019 and are used for Years 4 and 5.
6. The total annual emissions for CO_2 emission is in units of metric tons per year. The total annual emissions for VOC, CO, PM_{10}, $PM_{2.5}$, NO_x, and SO_2 is provided in units of tons per year.

CONUS CIS

FCTC Sites 1 and 2

Expedited Schedule

Summary of Air Emissions Estimate During Operation of the Potential CIS Deployment

Pollutant	Estimated Annual Emissions (ton/year) [1]	
	Year 4	Year 5
NO_X	13.3	53.2
VOC	12.3	49.2
SO_2	0.03	0.13
$PM_{2.5}$	0.4	1.6
PM_{10}	0.5	1.9
CO	25.9	102.8
GHG - CO_{2e} Basis	3,705	14,772

Notes [ ]:

1. The air emissions of carbon dioxide equivalents (CO_2e) are provided in metric tons per year. The air emissions of criteria pollutants are provided in tons per year.

APPENDIX D.3

CRJMTC Site

Air Quality Calculations

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Construction – Baseline Schedule

CRJMTC

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CRJMTC Construction CO_2 Emission Calculations
Baseline Schedule

Annual Emission Factors		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
		Emission Factors[1] (lb/hr)					
Activity	Construction Equipment Name	CO2	CO2	CO2	CO2	CO2	CO2
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Excavators Composite	119.57	119.57	119.57	119.57	119.57	119.57
	Off-Highway Trucks	260.05	260.05	260.05	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54	122.54	122.54	122.54
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Excavators Composite	119.57	119.57	119.57	119.57	119.57	119.57
	Graders Composite	132.74	132.74	132.74	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54	122.54	122.54	122.54
	Other Material Handling Equipment Composite	141.19	141.19	141.19	141.19	141.19	141.19
	Rollers Composite	67.046	67.046	67.046	67.046	67.046	67.046
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.89	164.89	164.89	164.89	164.89	164.89
	Crushing/Proc Equipment Composite	132.3	132.3	132.3	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74	132.74	132.74	132.74
	Other Construction Equipment Composite	122.54	122.54	122.54	122.54	122.54	122.54
	Rollers Composite	67.048	67.048	67.048	67.048	67.048	67.048

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.0 program.

Annual Estimated Emissions										Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Activity	Construction Equipment Name[1]	Number of Equipment Pieces[2]	Year 1 Days/yr[3]	Year 2 Days/yr[3]	Year 3 Days/yr[3]	Year 4 Days/yr[3]	Year 5 Days/yr[3]	Year 6 Days/yr[3]	Equipment Use (hpd)[4]	Metric Tons CO2	Metric Tons CO2	Metric Tons CO2	Metric Tons CO2	Metric Tons CO2	Metric Tons CO2
Tree Clearing (Months 1-6)	Air Compressors Composite	3	78	78	0	0	0	0	3.14	21.199	21.199	0.000	0.000	0.000	0.000
	Crawler Tractors Composite	4	78	78	0	0	0	0	3.04	49.050	49.050	0.000	0.000	0.000	0.000
	Crushing/Proc Equipment Composite	2	78	78	0	0	0	0	3.21	30.051	30.051	0.000	0.000	0.000	0.000
	Excavators Composite	4	78	78	0	0	0	0	6.22	105.253	105.253	0.000	0.000	0.000	0.000
	Off-Highway Trucks	1	78	78	0	0	0	0	0.01	0.092	0.092	0.000	0.000	0.000	0.000
	Other Construction Equipment Composite	1	78	78	0	0	0	0	0.30	1.301	1.301	0.000	0.000	0.000	0.000
	Rubber Tire Loaders Composite	2	78	78	0	0	0	0	1.86	14.295	14.295	0.000	0.000	0.000	0.000
Site Prep (Months 7-18)	Air Compressors Composite	3	0	234	78	0	0	0	3.14	0.000	63.597	21.199	0.000	0.000	0.000
	Bore/Drill Rigs Composite	2	0	234	78	0	0	0	0.42	0.000	14.702	4.901	0.000	0.000	0.000
	Crawler Tractors Composite	7	0	234	78	0	0	0	3.04	0.000	257.512	85.837	0.000	0.000	0.000
	Crushing/Proc Equipment Composite	1	0	234	78	0	0	0	3.21	0.000	45.076	15.025	0.000	0.000	0.000
	Excavators Composite	21	0	234	78	0	0	0	6.22	0.000	1657.731	552.577	0.000	0.000	0.000
	Graders Composite	1	0	234	78	0	0	0	5.59	0.000	78.758	26.253	0.000	0.000	0.000
	Off-Highway Trucks	1	0	234	78	0	0	0	0.01	0.000	0.276	0.092	0.000	0.000	0.000
	Other Construction Equipment Composite	1	0	234	78	0	0	0	0.30	0.000	3.902	1.301	0.000	0.000	0.000
	Other Material Handling Equipment Composite	3	0	234	78	0	0	0	3.24	0.000	145.664	48.555	0.000	0.000	0.000
	Rollers Composite	16	0	234	78	0	0	0	8.57	0.000	975.789	325.263	0.000	0.000	0.000
	Rubber Tire Loaders Composite	2	0	234	78	0	0	0	1.86	0.000	42.884	14.295	0.000	0.000	0.000
	Scrapers Composite	1	0	234	78	0	0	0	8.66	0.000	241.266	80.422	0.000	0.000	0.000
	Trenchers Composite	1	0	234	78	0	0	0	2.18	0.000	13.586	4.529	0.000	0.000	0.000
Construction (Months 19-42)	Aerial Lifts Composite	4	0	0	234	312	78	0	3.28	0.000	0.000	48.351	64.468	16.117	0.000
	Air Compressors Composite	5	0	0	234	312	78	0	6.31	0.000	0.000	213.003	284.004	71.001	0.000
	Bore/Drill Rigs Composite	1	0	0	234	312	78	0	2.25	0.000	0.000	39.378	52.505	13.126	0.000
	Concrete and Mortar Mixers	1	0	0	234	312	78	0	0.57	0.000	0.000	0.439	0.585	0.146	0.000
	Concrete/Industrial Saws Composite	1	0	0	234	312	78	0	1.13	0.000	0.000	7.012	9.349	2.337	0.000
	Cranes	21	0	0	234	312	78	0	2.15	0.000	0.000	616.380	821.840	205.460	0.000
	Crawler Tractors Composite	11	0	0	234	312	78	0	4.16	0.000	0.000	553.747	738.329	184.582	0.000
	Excavators Composite	1	0	0	234	312	78	0	0.47	0.000	0.000	5.965	7.953	1.988	0.000
	Generator Sets Composite	1	0	0	234	312	78	0	2.39	0.000	0.000	15.472	20.630	5.157	0.000
	Other Construction Equipment Composite	11	0	0	234	312	78	0	1.87	0.000	0.000	267.543	356.725	89.181	0.000
	Other General Industrial Equipment Composite	1	0	0	234	312	78	0	2.39	0.000	0.000	38.617	51.490	12.872	0.000
	Paving Equipment Composite	8	0	0	234	312	78	0	1.62	0.000	0.000	94.833	126.444	31.611	0.000
	Plate Compactors Composite	4	0	0	234	312	78	0	1.89	0.000	0.000	3.461	4.615	1.154	0.000
	Pumps Composite	12	0	0	234	312	78	0	6.05	0.000	0.000	382.255	509.673	127.418	0.000
	Rubber Tire Loaders Composite	16	0	0	234	312	78	0	3.48	0.000	0.000	641.876	855.835	213.959	0.000
	Surfacing Equipment Composite	1	0	0	234	312	78	0	1.77	0.000	0.000	31.179	41.572	10.393	0.000
	Tractors/Loaders/Backhoes Composite	2	0	0	234	312	78	0	0.86	0.000	0.000	12.195	16.259	4.065	0.000
	Trenchers Composite	1	0	0	234	312	78	0	0.05	0.000	0.000	0.312	0.415	0.104	0.000
	Welders Composite	22	0	0	234	312	78	0	8.88	0.000	0.000	530.874	707.832	176.958	0.000
1-Mo Construction (Month 38)	Paving Composite	5	0	0	0	26	0	0	4.59	0.000	0.000	0.000	18.659	0.000	0.000
Buildout (Months 43-54)	Bore/Drill Rigs Composite	8	0	0	0	0	234	78	7.92	0.000	0.000	0.000	0.000	1108.898	369.633
	Crushing/Proc Equipment Composite	1	0	0	0	0	234	78	0.62	0.000	0.000	0.000	0.000	8.706	2.902
	Graders Composite	1	0	0	0	0	234	78	1.31	0.000	0.000	0.000	0.000	18.457	6.152
	Other Construction Equipment Composite	2	0	0	0	0	234	78	0.14	0.000	0.000	0.000	0.000	3.642	1.214
	Rollers Composite	6	0	0	0	0	234	78	2.25	0.000	0.000	0.000	0.000	96.073	32.024
										Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Total CO2 Tons Emissions from Construction Equipment										221.24	3,761.98	4,683.14	4,689.18	2,403.41	411.93

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.

2. The analysis assumes that construction will occur 26 days per month. The EIS construction schedule states each piece of construction equipment is limited to a 10-hour per day schedule. Therefore, if an individual piece operates more that 10 hours per day during any of the four buildout periods, additional pieces of that same equipment will be used in the calculations, so that the total hours per day for each piece of equipment is always less than 10-hours per day.

3. Total days per year was determined by the construction schedule working 6 days a week per the EIS construction schedule.

CRJMTC Construction Worker Vehicle Estimated Emissions

Baseline Schedule

Air Emissions Estimate for Worker Vehicles duirng Construciton

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 1							Year 2							Year 3						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.454	0.010	0.012	0.460	4.567	362.109	0.007	0.395	0.010	0.011	0.340	3.981	354.124	0.002	0.355	0.009	0.010	0.291	3.737	345.601	0.002
Light-Duty Trucks	0.590	0.012	0.013	0.806	6.674	473.039	0.009	0.505	0.012	0.013	0.579	5.808	459.458	0.003	0.449	0.011	0.012	0.500	5.331	445.974	0.003

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.319	0.008	0.009	0.250	3.516	336.538	0.002	0.290	0.007	0.008	0.217	3.327	327.00	0.002	0.290	0.007	0.008	0.217	3.327	327.00	0.002
Light-Duty Trucks	0.401	0.010	0.012	0.432	4.907	433.169	0.003	0.361	0.010	0.011	0.377	4.554	420.846	0.003	0.361	0.010	0.011	0.377	4.554	420.846	0.003

Estimated Annual Air Emissions: Jan.-Sept. (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]						Year 1							Year 2							Year 3						
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	78	78	78	50	50	200	300	300	200	0.0976	0.0021	0.0026	0.0989	0.9817	70.6113	0.0015	0.0849	0.0021	0.0024	0.0731	0.8557	69.054	0.0004	0.3052	0.0077	0.0086	0.2502	3.2131	269.569	0.0017
Light-Duty Trucks	50	78	78	78	50	50	200	300	300	200	0.1268	0.0026	0.0028	0.1733	1.4346	92.24	0.0019	0.1086	0.0026	0.0028	0.1245	1.2484	89.59	0.0006	0.3861	0.0095	0.0103	0.4299	4.5836	347.86	0.0026
Total Annual Emissions from Worker Vehicles											0.2244	0.0047	0.0054	0.2721	2.4163	162.85	0.0034	0.1935	0.0047	0.0052	0.1975	2.1042	158.65	0.0011	0.6913	0.0172	0.0189	0.6801	7.7967	617.43	0.0043

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	0.4114	0.0103	0.0116	0.3224	4.5346	393.749	0.0026	0.3740	0.0090	0.0103	0.2799	4.2908	#######	0.0026	0.2493	0.0060	0.0069	0.1866	2.8606	#######	0.0017
Light-Duty Trucks	0.5172	0.0129	0.0155	0.5572	6.3286	506.81	0.0039	0.4656	0.0129	0.0142	0.4862	5.8733	492.39	0.0039	0.3104	0.0086	0.0095	0.3241	3.9155	328.26	0.0026
Total Annual Emissions from Worker Vehicles	0.9286	0.0232	0.0271	0.8796	10.8632	900.56	0.0064	0.8396	0.0219	0.0245	0.7661	10.1642	874.98	0.0064	0.5597	0.0146	0.0163	0.5107	6.7761	583.32	0.0043

Estimated Annual Air Emissions: Oct.-Dec. (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]						Year 1							Year 2							Year 3						
		Years 1-3	Year 4	Years 5-6	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	234	234	234	0	200	300	300	200	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.0189	0.0258	0.0284	0.8770	10.2686	828.650	0.0052	1.3735	0.0348	0.0387	1.1259	14.4589	1213.06	0.0077
Light-Duty Trucks	50	234	234	234	0	200	300	300	200	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.3026	0.0310	0.0335	1.4935	14.9812	1075.13	0.0077	1.7372	0.0426	0.0464	1.9346	20.6262	1565.37	0.0116
Total Annual Emissions from Worker Vehicles											0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	2.3215	0.0567	0.0619	2.3705	25.2498	1903.78	0.0129	3.1108	0.0774	0.0851	3.0605	35.0851	2778.43	0.0193

Vehicle Type	Year 4							Year 5							Year 6						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	1.2342	0.0310	0.0348	0.9673	13.6038	#######	0.0077	0.7480	0.0181	0.0206	0.5597	8.5817	765.175	0.0052	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	1.5515	0.0387	0.0464	1.6715	18.9857	1520.42	0.0116	0.9312	0.0258	0.0284	0.9724	11.7466	984.78	0.0077	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
Total Annual Emissions from Worker Vehicles	2.7858	0.0696	0.0813	2.6387	32.5895	2701.67	0.0193	1.6792	0.0438	0.0490	1.5322	20.3283	1749.95	0.0129	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000

Notes [ ]:

1. Portage County emission Factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model.
   The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2016 emission factors are used for Year 1, 2017 for Year 2, 2018 for Year 3, 2019 for Year 4, 2020 for Year 5, and 2020 for Year 6.
2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling within the non-attainment/maintenance area to and from the CRJMTC.
4. It is assumed that each month contains 26 work days, working 6 days a week over an average year of 365 days.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are expected based on the EIS construction schedule over the first year of construction, starting in Oct of Year 1. Conservatively assuming the truck traffic will mimic the worker schedule used in the passenger vehicle tab, 135 truck trips per day were assumed starting in Oct of Year 2 during the construction phase, and then again 90 truck trips for months 37-48 starting in October of Year 4.
6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

CRJMTC On-Road Haul/Delivery Truck Estimated Emissions

Baseline Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks duirng Construciton

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 1 VOC	Year 1 $PM_{2.5}$	Year 1 PM_{10}	Year 1 NOx	Year 1 CO	Year 1 CO_2	Year 1 SO_2	Year 2 VOC	Year 2 $PM_{2.5}$	Year 2 PM_{10}	Year 2 NOx	Year 2 CO	Year 2 CO_2	Year 2 SO_2	Year 3 VOC	Year 3 $PM_{2.5}$	Year 3 PM_{10}	Year 3 NOx	Year 3 CO	Year 3 CO_2	Year 3 SO_2
HDDV	0.629	0.271	0.295	6.872	2.247	1527.79	0.014	0.572	0.238	0.259	6.222	2.058	1513.72	0.013	0.520	0.206	0.223	5.605	1.884	1499.70	0.013

Vehicle Type	Year 4 VOC	Year 4 $PM_{2.5}$	Year 4 PM_{10}	Year 4 NOx	Year 4 CO	Year 4 CO_2	Year 4 SO_2	Year 5 VOC	Year 5 $PM_{2.5}$	Year 5 PM_{10}	Year 5 NOx	Year 5 CO	Year 5 CO_2	Year 5 SO_2	Year 6 VOC	Year 6 $PM_{2.5}$	Year 6 PM_{10}	Year 6 NOx	Year 6 CO	Year 6 CO_2	Year 6 SO_2
HDDV	0.473	0.179	0.194	5.062	1.732	1486.74	0.013	0.433	0.155	0.169	4.575	1.600	1474.65	0.013	0.433	0.155	0.169	4.575	1.600	1474.65	0.013

Estimated Annual Air Emissions: Jan.-Sept. (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4] Year 1	Days/Year[4] Years 2-5	Days/Year[4] Year 6	Trips/Day [5,6] Year 1	Trips/Day Year 2	Trips/Day Year 3	Trips/Day Year 4	Trips/Day Year 5	Trips/Day Year 6
HDDV	20	78	312	78	90	90	90	90	90	90

Vehicle Type	Year 1 VOC	Year 1 $PM_{2.5}$	Year 1 PM_{10}	Year 1 NO_x	Year 1 CO	Year 1 CO_2 [7]	Year 1 SO_2	Year 2 VOC	Year 2 $PM_{2.5}$	Year 2 PM_{10}	Year 2 NO_x	Year 2 CO	Year 2 CO_2 [7]	Year 2 SO_2	Year 3 VOC	Year 3 $PM_{2.5}$	Year 3 PM_{10}	Year 3 NO_x	Year 3 CO	Year 3 CO_2 [7]	Year 3 SO_2
HDDV	0.0973	0.0419	0.0457	1.0635	0.3478	#######	0.0022	0.3541	0.1473	0.1603	3.8518	1.2740	850.107	0.0080	0.3219	0.1275	0.1380	3.4698	1.1663	842.230	0.0080
Total Annual Emissions from Worker Vehicles	0.0973	0.0419	0.0457	1.0635	0.3478	214.50	0.0022	0.3541	0.1473	0.1603	3.8518	1.2740	850.11	0.0080	0.3219	0.1275	0.1380	3.4698	1.1663	842.23	0.0080

Vehicle Type	Year 4 VOC	Year 4 $PM_{2.5}$	Year 4 PM_{10}	Year 4 NO_x	Year 4 CO	Year 4 CO_2 [7]	Year 4 SO_2	Year 5 VOC	Year 5 $PM_{2.5}$	Year 5 PM_{10}	Year 5 NO_x	Year 5 CO	Year 5 CO_2 [7]	Year 5 SO_2	Year 6 VOC	Year 6 $PM_{2.5}$	Year 6 PM_{10}	Year 6 NO_x	Year 6 CO	Year 6 CO_2 [7]	Year 6 SO_2
HDDV	0.2928	0.1108	0.1201	3.1337	1.0722	834.954	0.0080	0.2681	0.0960	0.1046	2.8322	0.9905	#######	0.0080	0.0670	0.0240	0.0262	0.7080	0.2476	#######	0.0020
Total Annual Emissions from Worker Vehicles	0.2928	0.1108	0.1201	3.1337	1.0722	834.95	0.0080	0.2681	0.0960	0.1046	2.8322	0.9905	828.17	0.0080	0.0670	0.0240	0.0262	0.7080	0.2476	207.04	0.0020

Notes [ ]:

1. Portage County emission Factors for Heavy Duty Diesel Viehicles (HDDV) are from USAF 's ACAM model.
   The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2016 emission factors are used for Year 1, 2017 for Year 2, 2018 for Year 3, 2019 for Year 4, 2020 for Year 5, and 2020 for Year 6.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the FCTC Site 1 site to an offsite dump location.
4. It is assumed that each month contains 26 work days, working 6 days a week over an average year of 365 days.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are expected based on the EIS construction schedule throughout construction.
6. It is assumed that a dump or haul truck will be used during site preparation, construction and buildout. The truck trips per day are based on truck projections for the first 12 months of site preparation.
   These truck numbers were then averaged over the entire four year work period using the same ratio that was applied to the overall workforce referenced in the DOPAA.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

CRJMTC Total Emissions

Baseline Schedule

CRJMTC Estimated Air Emissions During Construction

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)	General Conformity Threshold [4] (ton/yr)
Year 1					
VOC	0.23	0.22	0.10	0.56	100
NO_X	1.59	0.27	1.06	2.93	100
SO_X	0.003	0.003	0.002	0.009	100
$PM_{2.5}$	0.09	0.00	0.04	0.14	100
PM_{10}	0.09	0.01	0.05	0.14	N/A
CO	1.12	2.42	0.35	3.88	N/A
CO_2 [4]	221.24	162.85	214.50	598.60	N/A
Year 2					
VOC	4.34	2.51	0.35	7.20	100
NO_X	28.98	2.57	3.85	35.40	100
SO_X	0.051	0.014	0.008	0.073	100
$PM_{2.5}$	1.60	0.06	0.15	1.81	100
PM_{10}	5,139.46	0.07	0.16	5,139.69	N/A
CO	22.47	27.35	1.27	51.10	N/A
CO_2 [4]	3,761.98	2,062.43	850.11	6,674.52	N/A
Year 3					
VOC	5.02	3.80	0.32	9.14	100
NO_X	33.11	3.74	3.47	40.32	100
SO_X	0.057	0.024	0.008	0.089	100
$PM_{2.5}$	1.82	0.09	0.13	2.04	100
PM_{10}	1,714.44	0.10	0.14	1,714.68	N/A
CO	25.16	42.88	1.17	69.21	N/A
CO_2 [4]	4,683.14	3,395.86	842.23	8,921.23	N/A
Year 4					
VOC	4.93	3.71	0.29	8.94	100
NO_X	32.14	3.52	3.13	38.79	100
SO_X	0.055	0.026	0.008	0.089	100
$PM_{2.5}$	1.76	0.09	0.11	1.97	100
PM_{10}	1.76	0.11	0.12	1.99	N/A
CO	24.21	43.45	1.07	68.73	N/A
CO_2 [4]	4,689.18	3,602.23	834.95	9,126.36	N/A
Year 5					
VOC	1.69	2.52	0.27	4.47	100
NO_X	11.28	2.30	2.83	16.41	100
SO_X	0.028	0.019	0.008	0.055	100
$PM_{2.5}$	0.53	0.07	0.10	0.69	100
PM_{10}	0.53	0.07	0.10	0.71	N/A
CO	10.48	30.49	0.99	41.96	N/A
CO_2 [4]	2,403.41	2,624.93	828.17	5,856.50	N/A
Year 6					
VOC	0.16	0.56	0.07	0.78	100
NO_X	1.10	0.51	0.71	2.32	100
SO_X	0.005	0.004	0.002	0.011	100
$PM_{2.5}$	0.03	0.01	0.02	0.07	100
PM_{10}	0.03	0.02	0.03	0.07	N/A
CO	1.49	6.78	0.25	8.51	N/A
CO_2 [4]	411.93	583.32	207.04	1,202.28	N/A

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculted in the tabs on this spreadsheet using emission factors from the ACAM 5.02 model and is provided in metric tons.

Construction – Expedited Schedule

CRJMTC

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CRJMTC Construction CO_2 Emission Calculations

Expedited Schedule

Annual Emission Factors		Year 2	Year 3	Year 4
		Emission Factors [1] (lb/hr)		
Activity	**Construction Equipment Name**	**CO2**	**CO2**	**CO2**
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54
	Rubber Tire Loaders Composite	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.57	119.57	119.57
	Graders Composite	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other Material Handling Equipment Composite	141.19	141.19	141.19
	Rollers Composite	67.046	67.046	67.046
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.87	164.87	164.87
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74
	Other Construction Equipment Composite	122.50	122.50	122.50
	Rollers Composite	67.042	67.042	67.042

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.02 program.

Annual Estimated Emissions							Year 2	Year 3	Year 4
Activity	**Construction Equipment Name [1]**	**Number of Equipment Pieces [2]**	**Year 2 Days/yr [3]**	**Year 3 Days/yr [3]**	**Year 4 Days/yr [3]**	**Equipment Use (hpd) [4]**	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**
Tree Clearing (Months 4-7)	Air Compressors Composite	3	120	0	0	6.28	65.228	0.000	0.000
	Crawler Tractors Composite	4	120	0	0	6.08	150.923	0.000	0.000
	Crushing/Proc Equipment Composite	2	120	0	0	6.42	92.464	0.000	0.000
	Excavators Composite	4	120	0	0	12.44	323.882	0.000	0.000
	Off-Highway Trucks	1	120	0	0	0.02	0.283	0.000	0.000
	Other Construction Equipment Composite	1	120	0	0	0.60	4.002	0.000	0.000
	Rubber Tire Loaders Composite	2	120	0	0	3.72	43.984	0.000	0.000
Site Prep (Months 8-14)	Air Compressors Composite	3	214	0	0	6.28	116.323	0.000	0.000
	Bore/Drill Rigs Composite	2	214	0	0	0.84	26.891	0.000	0.000
	Crawler Tractors Composite	7	214	0	0	6.08	471.004	0.000	0.000
	Crushing/Proc Equipment Composite	1	214	0	0	6.42	82.447	0.000	0.000
	Excavators Composite	21	214	0	0	12.44	3032.089	0.000	0.000
	Graders Composite	1	214	0	0	11.18	144.053	0.000	0.000
	Off-Highway Trucks	1	214	0	0	0.02	0.505	0.000	0.000
	Other Construction Equipment Composite	1	214	0	0	0.60	7.137	0.000	0.000
	Other Material Handling Equipment Composite	3	214	0	0	6.48	266.428	0.000	0.000
	Rollers Composite	16	214	0	0	17.14	1784.776	0.000	0.000
	Rubber Tire Loaders Composite	2	214	0	0	3.72	78.437	0.000	0.000
	Scrapers Composite	1	214	0	0	17.32	441.290	0.000	0.000
	Trenchers Composite	1	214	0	0	4.36	24.849	0.000	0.000
Construction (Months 15-29)	Aerial Lifts Composite	4	31	365	59	6.56	12.811	150.840	24.382
	Air Compressors Composite	5	31	365	59	12.62	56.437	664.498	107.412
	Bore/Drill Rigs Composite	1	31	365	59	4.50	10.434	122.847	19.858
	Concrete and Mortar Mixers	1	31	365	59	1.14	0.116	1.368	0.221
	Concrete/Industrial Saws Composite	1	31	365	59	2.26	1.858	21.875	3.536
	Cranes	21	31	365	59	4.30	163.314	1922.894	310.824
	Crawler Tractors Composite	11	31	365	59	8.32	146.719	1727.500	279.240
	Excavators Composite	1	31	365	59	0.94	1.580	18.608	3.008
	Generator Sets Composite	1	31	365	59	4.78	4.099	48.268	7.802
	Other Construction Equipment Composite	11	31	365	59	3.74	70.888	834.644	134.915
	Other General Industrial Equipment Composite	1	31	365	59	4.78	10.232	120.472	19.474
	Paving Equipment Composite	8	31	365	59	3.24	25.127	295.846	47.822
	Plate Compactors Composite	4	31	365	59	3.78	0.917	10.799	1.746
	Pumps Composite	12	31	365	59	12.10	101.281	1192.504	192.761
	Rubber Tire Loaders Composite	16	31	365	59	6.96	170.070	2002.434	323.681
	Surfacing Equipment Composite	1	31	365	59	3.54	8.261	97.267	15.723
	Tractors/Loaders/Backhoes Composite	2	31	365	59	1.72	3.231	38.043	6.149
	Trenchers Composite	1	31	365	59	0.10	0.083	0.972	0.157
	Welders Composite	22	31	365	59	17.76	140.659	1656.146	267.706
1-Mo Construction (Month 23)	Paving Composite	5	0	31	0	9.18	0.000	44.495	0.000
Buildout (Months 30-36)	Bore/Drill Rigs Composite	8	0	0	214	15.84	0.000	0.000	2027.995
	Crushing/Proc Equipment Composite	1	0	0	214	1.24	0.000	0.000	15.924
	Graders Composite	1	0	0	214	2.62	0.000	0.000	33.758
	Other Construction Equipment Composite	2	0	0	214	0.28	0.000	0.000	6.659
	Rollers Composite	6	0	0	214	4.50	0.000	0.000	175.708
							Year 2	**Year 3**	**Year 4**
Total CO2 Tons Emissions from Construction Equipment							**8,085.11**	**10,972.32**	**4,026.46**

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.

2. The analysis assumes that construction will occur every day of the month.

3. Total days per year was determined by the construction schedule working 7 days a week per the EIS construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1.

4. The number of equipment pieces assumes the same quantities used in the baseline construction schedule, but the hours per day are double the hours used in the baseline construction schedule.

CRJMTC Construction Worker Vehicle Estimated Emissions

Expedited Schedule

Air Emissions Estimate for Worker Vehicles during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.395	0.010	0.011	0.340	3.981	354.124	0.002	0.355	0.009	0.010	0.291	3.737	345.601	0.002	0.319	0.008	0.009	0.250	3.516	336.538	0.002
Light-Duty Trucks	0.505	0.012	0.013	0.579	5.808	459.458	0.003	0.449	0.011	0.012	0.500	5.331	445.974	0.003	0.401	0.010	0.012	0.432	4.907	433.169	0.003

Estimated Annual Air Emissions: Jan - Apr. Year 2 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	120	0	0	100	0	0	0.2612	0.0066	0.0073	0.2249	2.6330	212.474	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	50	120	0	0	100	0	0	0.3340	0.0079	0.0086	0.3829	3.8413	275.67	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
		Total Annual Emissions from Worker Vehicles						**0.5952**	**0.0146**	**0.0159**	**0.6078**	**6.4743**	**488.15**	**0.0033**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**

Estimated Annual Air Emissions: May - Nov. Year 2, Mar - Sep. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	214	0	214	400	0	400	1.8636	0.0472	0.0519	1.6041	18.7819	1515.65	0.0094	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.5050	0.0377	0.0425	1.1795	16.5881	1440.38	0.0094
Light-Duty Trucks	50	214	0	214	400	0	400	2.3825	0.0566	0.0613	2.7317	27.4015	1966.48	0.0142	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.8919	0.0472	0.0566	2.0381	23.1507	1853.96	0.0142
		Total Annual Emissions from Worker Vehicles						**4.2461**	**0.1038**	**0.1132**	**4.3357**	**46.1835**	**3482.13**	**0.0236**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**3.3969**	**0.0849**	**0.0991**	**3.2176**	**39.7388**	**3294.35**	**0.0236**

Estimated Annual Air Emissions: Dec. Year 2 - Feb. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	31	365	59	600	600	600	0.4049	0.0103	0.0113	0.3486	4.0811	329.335	0.0021	4.2850	0.1086	0.1207	3.5125	45.1067	3784.33	0.0241	0.6224	0.0156	0.0176	0.4878	6.8600	595.67	0.0039
Light-Duty Trucks	50	31	365	59	600	600	600	0.5177	0.0123	0.0133	0.5936	5.9541	427.30	0.0031	5.4196	0.1328	0.1448	6.0352	64.3468	4883.42	0.0362	0.7824	0.0195	0.0234	0.8429	9.5740	766.71	0.0059
		Total Annual Emissions from Worker Vehicles						**0.9226**	**0.0226**	**0.0246**	**0.9421**	**10.0352**	**756.63**	**0.0051**	**9.7045**	**0.2414**	**0.2655**	**9.5476**	**109.45**	**8667.75**	**0.0604**	**1.4048**	**0.0351**	**0.0410**	**1.3306**	**16.434**	**1362.38**	**0.0098**

Notes [ ]:

1. Portage County emission Factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4. The expedited construction schedule will occur during Years 2-4.

2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.

3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling to and from the CRJMTC.
4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.

5. Trips/Day are based on monthly project estimates for the expected distribution of workers averaged over each year of the expected construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1. The analysis uses 200 workers during months 4-7 starting in January of Year 2, 800 construction workers during months 8-14 starting in May of Year 2, 1200 workers during months 15-29 starting December of Year 2, and 800 construction workers during months 30-36 starting in March of Year 4.
6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

CRJMTC On-Road Haul/Delivery Truck Estimated Emissions

Expedited Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.572	0.238	0.259	6.222	2.058	1513.72	0.013	0.520	0.206	0.223	5.605	1.884	1499.70	0.013	0.473	0.179	0.194	5.062	1.732	1486.74	0.013

Estimated Annual Air Emissions (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	20	365	365	273	90	90	90	0.4143	0.1724	0.1876	4.5061	1.4904	994.516	0.0094
Total Annual Emissions from Haul/Delivery Trucks								**0.4143**	**0.1724**	**0.1876**	**4.5061**	**1.4904**	**994.52**	**0.0094**

Vehicle Type	Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	0.3766	0.1492	0.1615	4.0592	1.3644	985.301	0.0094	0.2562	0.0970	0.1051	2.7420	0.9382	730.585	0.0070
Total Annual Emissions from Haul/Delivery Trucks	**0.3766**	**0.1492**	**0.1615**	**4.0592**	**1.3644**	**985.30**	**0.0094**	**0.2562**	**0.0970**	**0.1051**	**2.7420**	**0.9382**	**730.58**	**0.0070**

Notes [ ]:

1. Portage County emission Factors for Heavy Duty Diesel Vehicles (HDDV) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the CRJMTC site to an off base location.
4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are assumed for all years of construction. It is assumed that the on road haul/delivery trucks will be used to removed construction waste from the site, remove cut from or deliver fill to the site, deliver construction materials to the site, and other types of activities during construction.
6. It is assumed that the final design would be completed and required permits would be obtained in Year 1. Tree clearing is expected to start in January of Year 2 to April of Year 2. Site preparation is expected to take place starting in May of Year 2 through November of Year 2. Heavy construction is expected to start in December of Year 2 through February of Year 4. Buildout is expected to start in March of Year 4 through September of Year 4.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

CRJMTC Total Emissions

Expedited Schedule

CRJMTC Estimated Air Emissions During Construction

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
Year 2				
VOC	7.71	5.76	0.41	13.89
NO_X	51.36	5.89	4.51	61.75
SO_X	1.409	0.032	0.009	1.450
$PM_{2.5}$	2.84	0.14	0.17	3.15
PM_{10}	3,917.40	0.15	0.19	3,917.74
CO	39.55	62.69	1.49	103.74
CO_2e [4]	8,085.11	4,726.91	994.52	13,806.54
Year 3				
VOC	13.80	9.70	0.38	23.88
NO_X	90.65	9.55	4.06	104.25
SO_X	15.980	0.060	0.009	16.050
$PM_{2.5}$	5.10	0.24	0.15	5.49
PM_{10}	1,962.38	0.27	0.16	1,962.80
CO	65.38	109.45	1.36	176.20
CO_2e [4]	10,972.32	8,667.75	985.30	20,625.37
Year 4				
VOC	2.54	4.80	0.26	7.60
NO_X	17.17	4.55	2.74	24.46
SO_X	2.679	0.033	0.007	2.719
$PM_{2.5}$	0.82	0.12	0.10	1.04
PM_{10}	0.82	0.14	0.11	1.06
CO	15.09	56.17	0.94	72.20
CO_2e [4]	4,026.46	4,656.73	730.58	9,413.77

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculated in the tabs on this spreadsheet using emission factors from ACAM 5.02 and is given in metric tons.

Operation – Baseline Schedule

CRJMTC

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CONUS CIS

Camp Ravenna Joint Military Training Center (CRJMTC)

Baseline Schedule

Air Emissions Estimate for Power Plant Generators

Basis:

Number of Units	4	
Fuel	Diesel Fuel Oil	
Power Rating	3,000	kW
Heat Input	28.87	mmBtu/hr
Heating Value of Fuel	137,000	Btu/gal [2]
Fuel Burn Rate	211	gal/hr [1]
Hours of Operation	500	hours per year
Density of Fuel	7.05	lb/gal [2]
Sulfur Content of Fuel	0.0015	% [3]

Global Warming Potentials [4]

CO_2	1
CH_4	25
N_2O	298

Pollutant	Mass Emission Rate				Annual Emissions (tpy)	
	g/kw-hr	lb/mmBtu	Notes	(lb/hr)	Year 6	Year 7
CO	3.50		[8]	23.15	17.36	23.15
NO_X	6.40		[8]	42.33	31.75	42.33
PM	0.20		[8]	1.32	0.99	1.32
PM_{10}	0.20		[5]	1.32	0.99	1.32
$PM_{2.5}$	0.20		[5]	1.32	0.99	1.32
SO_2	0.0067		[6]	0.045	0.033	0.045
VOC	6.40		[8,9]	42.33	31.75	42.33
GHG-Mass	--	--	[8]	4,707	3,530	4,707
CO_2	--	1.63E+02	[10]	4,706.70	3,530	4,707
CH_4	--	6.61E-03	[10]	0.19	0.14	0.19
N_2O	--	1.32E-03	[10]	3.82E-02	0.03	0.04
GHG-CO2e	--		[7]	4,723	3,213	4,284
CO_2	--		[4]	4,707	3,202	4,270
CH_4	--		[4]	4.77	3.25	4.33
N_2O	--		[4]	11.4	7.74	10.32

Notes [ ]:

1. Based on manufacturer's specifications for Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum power rating.
2. Based on diesel fuel characteristics listed in Reference 1.
3. Based on the requirements of 40 CFR Part 63, Subpart ZZZZ and 40 CFR Part 80.510(b).
4. CO_2 equivalents (CO_2e) Is provided in metric tons and is based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
5. It is assumed that the PM_{10} and $PM_{2.5}$ emission factors are the same as PM.
6. Assumed all sulfur in the fuel is converted to SO_2.
7. The GHG emissions is the sum of all applicable GHG pollutants.
8. Emission limits for Tier II engine manufactured after 2010 and >900 kW - 40 CFR §89.112(a), Table 1.
9. Emission limit provided by Tier II standards is for NO_X+NMHC. Engine VOC emissions were conservatively assumed to be equal to the entire emission limit of 6.4 g/kW-hr.
10. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

Camp Ravenna Joint Military Training Center (CRJMTC)
Baseline Schedule
Air Emissions Estimate for 7 MMBtu/hr Boilers

Basis:

Number of Boilers	1	
Fuel	Diesel Fuel Oil	

Boiler Information

Heat Input	7.0	MMBtu/hr [1]
Heating Value of Fuel	137,000	Btu/gal[2]
Fuel Burn Rate	51	gal/hr
Hours of Operation (Per Boiler)	8,760	hours per year
Annual Fuel Usage (Cumulative)	447,591	gal/year
Sulfur Content of Fuel	0.0015	%

Miscellaneous Data

Density of Fuel Oil	7.05	lb/gal[2]
SO_2 to SO_3 Conversion Rate	100	% by volume (assumed)
Molecular Weight of Sulfur	32	lb/lb-mol
Molecular Weight of Oxygen	16	lb/lb-mol
Molecular Weight of Hydrogen	1	lb/lb-mol

Global Warming Potentials [10]	
CO_2	1
CH_4	25
N_2O	298

Boiler Emissions Summary

Pollutant	Mass Emission Rate (per unit)				Annual Emissions (tpy)	
	(lb/gal)	(lb/MMBtu)	Notes	(lb/hr)	Year 6 [11]	Year 7 [12]
CO	0.005	0.036	[5]	0.26	0.84	1.12
NO_X	0.02	0.146	[5]	1.02	3.36	4.48
PM (total)	0.0033	0.0241	[2,3,5]	0.169	0.55	0.74
PM (filterable)	0.0020	0.0146	[2,3,5]	0.102	0.34	0.45
PM (condensable)	0.0013	0.0095	[2,3]	0.066	0.22	0.29
PM_{10}		0.012	[7]	0.08	0.28	0.37
$PM_{2.5}$		0.003	[7]	0.020	0.07	0.09
SO_2	2.12E-04	1.54E-03	[4]	1.08E-02	0.04	0.05
VOC	2.52E-04	1.84E-03	[8]	1.29E-02	0.04	0.06
GHG-Mass		--	[9]	1,141.43	3,749.61	4,999.48
CO_2	--	1.63E+02	[6]	1,141	3,749.42	4,999.23
CH_4	--	6.61E-03	[6]	4.63E-02	0.15	0.20
N_2O	--	1.32E-03	[6]	9.26E-03	0.03	0.04
GHG-CO2e	--	--	[9]	1,145	3,413.09	4,550.79
CO_2	--	--	[10]	1,141	3,401.42	4,535.23
CH_4	--	--	[10]	1.16	3.45	4.60
N_2O	--	--	[10]	2.76	8.22	10.96

Notes [ ]:
1. Based on preliminary vendor data.
2. Based on fuel characteristics listed in Reference 2.
3. Total particulate matter is the sum of filterable and condensable PM, given in AP-42 (Reference 1b).
4. Assumed all sulfur in the fuel is converted to SO_2.
5. Criteria pollutant emission factors obtained from AP-42 (Reference 1a) for boilers < 100 Million Btu/hr.
6. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.
7. Particle size distribution obtained from AP-42 (Reference 1c).
8. AP-42 includes VOCs within Total Organic Compounds (TOCs), which also includes semi-volatile organic compounds and condensable organic compounds (Reference 1d).
9. The GHG emissions is the sum of all applicable GHG pollutants.
10. CO_2 equivalents (CO_2e) based on global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
11. Emissions for Year 6 are based on operations beginning in April (9 months of the year).
12. Emissions for tons in Year 7 are based on operations for a full annual period.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Chapter 1 "External Combustion Sources", Section 1.3 "Fuel Oil Combustion". September 1999.
   a. Table 1.3-1 "Criteria Pollutant Emission Factors for Fuel Oil Combustion".
   b. Table 1.3-2 "Condensable Particulate Matter Emission Factors for Oil Combustion"
   c. Table 1.3-6 "Cumulative Particle Size Distribution and Size-Specific Emission Factors for Uncontrolled Industrial Boilers Firing Distillate Oil."
   d. Table 1.3-3 "Emission Factors for Total Organic Compounds (TOC), Methane, and Nonmethane TOC (NMTOC) From Uncontrolled Fuel Oil Combustion."
2. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

CRJMTC

Baseline Schedule

Calculate Annual Fuel Usage for Fuel Storage Tanks During Operations

Fuel Tank Diameter [(1)] (ft)	Fuel Tank Length [(1)] (ft)	Type of Fuel Tank [(2)]	Fuel Tank Capacity [(2)] (gal)	Number of Tanks [(2)]	Number of RICE Engines	Hours Per Year of RICE Engines [(3)]	Fuel Consumption Rate [(4)] (gal/hr)	Annual Fuel Consumption (gal/yr)	Annual Tank Turnovers
5.42	9	Vertical	1,500	4	4	500	210.7	421,400	280.93
10	51	Horizontal	30,000	3	4	500	210.7	421,400	14.05

Notes [ ]:

1. The fuel tank diameter and length were estimated using the National Board Standards from Engineering Toolbox Website (http://www.engineeringtoolbox.com/fuel-oil-storage-tanks-dimensions-d_1585.html). These numbers are used as input into the USAF's ACAM model to estimate VOC emissions from the fuel storage tanks.
2. The potential fuel storage tank parameters (i.e., type, number, and capacity) are based on information contained in the potential CIS deployment's Section 2.3 of the EIS.
3. The emission anlayis for the backup RICE engines assumes that the engines will operate 500 hours or less per year.
4. Fuel consumption rates are based on the manufacturer's specifications for a Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum operating at maximum load.

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Camp Ravenna Joint Military Training Center (CRJMTC)

Baseline Schedule

Air Emissions Estimate for Fuel Storage Tanks During Operations

Emission Activitiy	Estimated Annual Air Emissions (tons/year) [6]													
	Year 6							Year 7						
	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Fuel Storage Tanks	0.048	0	0	0	0	0	0	0.064	0	0	0	0	0	0

Notes [ ]:

1. The fuel storage tanks will emit VOC's during operations. The amount of VOC's emitted was estimated using the USAF's ACAM model (Version 5.02) using as input the dimensions of the tank and the amount of turnovers per year for each tank.

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Camp Ravenna Joint Military Training Center (CRJMTC)

Baseline Schedule

Air Emissions Estimate for Worker Vehicles During Operations

Vehicle Type [1]	Trips/ Day [2]	Days/Year [3] Year 6	Days/Year [3] Year 7	Miles/ Trip [4]	Emission Factor (g/mi) [5] VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	Estimated Annual Air Emissions (tons/year) [6] Year 6 VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	Year 7 VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Passenger Car	425	275	365	50	0.290	3.327	0.008	0.007	0.217	327.00	0.002	1.87	21.43	0.05	0.05	1.40	1,911	0.013	2.48	28.45	0.07	0.06	1.86	2,536	0.017
Light Duty Truck	425	275	365	50	0.361	4.554	0.011	0.010	0.377	420.85	0.003	2.33	29.34	0.07	0.06	2.43	2,459	0.019	3.09	38.94	0.09	0.09	3.22	3264.19	0.026
											Total Annual Emission	4.19	50.77	0.12	0.11	3.83	4,370	0.032	5.57	67.38	0.16	0.15	5.08	5,800	0.043

Notes [ ]:

1. It is assumed that the fleet of worker vehicles will be 50% passenger cars and 50% light-duty gasoline trucks.
2. Trips per day is based on the maximum number of workers during operation of the potential CIS deployment as listed in Section 2.3 of the EIS. A maximum of 850 workers are expected daily which is split between the two vehicle types. The workers include military, civilian, and contractor support maintenance personnel.
3. Days per year assumes that the potential CIS deployment will require workers traveling to the site each day of the year. It is assumed that operations will start in April of Year 6.
4. Total miles/trip is an average roundtrip distance traveled by the worker vehicles in the county to account for indirect emissions during operation of the potential CIS deployment. The analysis assumes this distance to be one-half the distance from the CRJMTC to the northwest corner of Lorain County, Ohio.
5. The emission factors are from the United States Air Force (USAF) Air Conformity Applicability Model (ACAM). The ACAM model emission factors are derived from the United States Environmental Protection Agency (USEPA) Motor Vehicle Emission Simulator (MOVES) computer model. Emission Factors are for 2020 and are used for Years 6 and 7 (Years 2021 and 2022, respectively).
6. The total annual emissions for CO_2 emission is in units of metric tons per year. The total annual emissions for VOC, $PM_{2.5}$, NO_x, and SO_2 is provided in units of tons per year.

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Camp Ravenna Joint Military Training Center (CRJMTC)

Baseline Schedule

Summary of Emissions During Operation of CIS

Pollutant	ANNUAL EMISSIONS (TPY) [1]		CONFORMITY APPLICABILITY THRESHOLD (TPY)	EXCEEDANCE OF THRESHOLD? (YES/NO)	
	Year 6	Year 7		Year 6	Year 7
NO_X	38.9	51.9	100	No	No
VOC	36.0	48.0	100	No	No
SO_2	0.10	0.13	100	No	No
$PM_{2.5(filterable+condensible)}$	1.2	1.6	100	No	No
PM_{10}	1.4	1.9	--	--	--
CO	69.0	91.6	--	--	--
GHG - CO_{2e} Basis	10,997	14,636	--	--	--

Notes [ ]:

1. The air emissions of carbon dioxide equivalents (CO_2e) are provided in metric tons per year.
   The air emissions of criteria pollutants are provided in tons per year.

Operation – Expedited Schedule

CRJMTC

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CONUS CIS

Camp Ravenna Joint Military Training Center (CRJMTC)

Expedited Schedule

Air Emissions Estimate for Power Plant Generators

Basis:

Number of Units	4	
Fuel	Diesel Fuel Oil	
Power Rating	3,000	kW
Heat Input	28.87	mmBtu/hr
Heating Value of Fuel	137,000	Btu/gal [2]
Fuel Burn Rate	211	gal/hr [1]
Hours of Operation	500	hours per year
Density of Fuel	7.05	lb/gal [2]
Sulfur Content of Fuel	0.0015	% [3]

Global Warming Potentials [4]

CO_2	1
CH_4	25
N_2O	298

Pollutant	Mass Emission Rate				Annual Emissions (tpy)	
	g/kw-hr	lb/mmBtu	Notes	lb/hr	Year 4	Year 5
CO	3.50		[8]	23.15	5.79	23.15
NO_X	6.40		[8]	42.33	10.58	42.33
PM	0.20		[8]	1.32	0.33	1.32
PM_{10}	0.20		[5]	1.32	0.33	1.32
$PM_{2.5}$	0.20		[5]	1.32	0.33	1.32
SO_2	0.0067		[6]	0.045	0.011	0.045
VOC	6.40		[8,9]	42.33	10.58	42.33
GHG-Mass	--	--	[8]	4,707	1,177	4,707
CO_2	--	1.63E+02	[10]	4,706.70	1,177	4,707
CH_4	--	6.61E-03	[10]	0.19	0.05	0.19
N_2O	--	1.32E-03	[10]	3.82E-02	0.01	0.04
GHG-CO2e	--		[7]	4,723	1,071	4,284
CO_2	--		[4]	4,707	1,067	4,270
CH_4	--		[4]	4.77	1.08	4.33
N_2O	--		[4]	11.4	2.58	10.32

Notes [ ]:

1. Based on manufacturer's specifications for Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum power rating.
2. Based on diesel fuel characteristics listed in Reference 1.
3. Based on the requirements of 40 CFR Part 63, Subpart ZZZZ and 40 CFR Part 80.510(b).
4. CO_2 equivalents (CO_2e) provided in metric tons based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
5. It is assumed that the PM_{10} and $PM_{2.5}$ emission factors are the same as PM.
6. Assumed all sulfur in the fuel is converted to SO_2.
7. The GHG emissions is the sum of all applicable GHG pollutants.
8. Emission limits for Tier II engine manufactured after 2010 and >900 kW - 40 CFR §89.112(a), Table 1.
9. Emission limit provided by Tier II standards is for NO_X+NMHC. Engine VOC emissions were conservatively assumed to be equal to the entire emission limit of 6.4 g/kW-hr.
10. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

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Camp Ravenna Joint Military Training Center (CRJMTC)
Expedited Schedule
Air Emissions Estimate for 7 MMBtu/hr Boilers

Basis:

Number of Boilers	1	
Fuel	Diesel Fuel Oil	

Boiler Information

Heat Input	7.0	MMBtu/hr [1]
Heating Value of Fuel	137,000	Btu/gal[2]
Fuel Burn Rate	51	gal/hr
Hours of Operation (Per Boiler)	8,760	hours per year
Annual Fuel Usage (Cumulative)	447,591	gal/year
Sulfur Content of Fuel	0.0015	%

Miscellaneous Data

Density of Fuel Oil	7.05	lb/gal[2]
SO_2 to SO_3 Conversion Rate	100	% by volume (assumed)
Molecular Weight of Sulfur	32	lb/lb-mol
Molecular Weight of Oxygen	16	lb/lb-mol
Molecular Weight of Hydrogen	1	lb/lb-mol

Global Warming Potentials [10]	
CO_2	1
CH_4	25
N_2O	298

Boiler Emissions Summary

Pollutant	Mass Emission Rate (per unit)				Annual Emissions (tpy)	
	(lb/gal)	(lb/MMBtu)	Notes	(lb/hr)	Year 4 [11]	Year 5 [12]
CO	0.005	0.036	[5]	0.26	0.28	1.12
NO_X	0.02	0.146	[5]	1.02	1.12	4.48
PM (total)	0.0033	0.0241	[2,3,5]	0.169	0.18	0.74
PM (filterable)	0.0020	0.0146	[2,3,5]	0.102	0.11	0.45
PM (condensable)	0.0013	0.0095	[2,3]	0.066	0.07	0.29
PM_{10}		0.012	[7]	0.08	0.09	0.37
$PM_{2.5}$		0.003	[7]	0.020	0.02	0.09
SO_2	2.12E-04	1.54E-03	[4]	1.08E-02	0.01	0.05
VOC	2.52E-04	1.84E-03	[8]	1.29E-02	0.01	0.06
GHG-Mass		--	[9]	1,141.43	1,249.87	4,999.48
CO_2	--	1.63E+02	[6]	1,141	1,249.81	4,999.23
CH_4	--	6.61E-03	[6]	4.63E-02	0.05	0.20
N_2O	--	1.32E-03	[6]	9.26E-03	0.01	0.04
GHG-CO2e	--	--	[9]	1,145	1,137.70	4,550.79
CO_2	--	--	[10]	1,141	1,133.81	4,535.23
CH_4	--	--	[10]	1.16	1.15	4.60
N_2O	--	--	[10]	2.76	2.74	10.96

Notes [ ]:

1. Based on preliminary vendor data.
2. Based on fuel characteristics listed in Reference 2.
3. Total particulate matter is the sum of filterable and condensable PM, given in AP-42 (Reference 1b).
4. Assumed all sulfur in the fuel is converted to SO_2.
5. Criteria pollutant emission factors obtained from AP-42 (Reference 1a) for boilers < 100 Million Btu/hr.
6. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.
7. Particle size distribution obtained from AP-42 (Reference 1c).
8. AP-42 includes VOCs within Total Organic Compounds (TOCs), which also includes semi-volatile organic compounds and condensable organic compounds (Reference 1d).
9. The GHG emissions is the sum of all applicable GHG pollutants.
10. CO_2 equivalents (CO_2e) based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
11. Emissions for Year 4 are based on operations beginning in October (3 months of the year).
12. Emissions for tons in Year 5 are based on operations for a full annual period.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Chapter 1 "External Combustion Sources", Section 1.3 "Fuel Oil Combustion". September 1999.
   a. Table 1.3-1 "Criteria Pollutant Emission Factors for Fuel Oil Combustion".
   b. Table 1.3-2 "Condensable Particulate Matter Emission Factors for Oil Combustion"
   c. Table 1.3-6 "Cumulative Particle Size Distribution and Size-Specific Emission Factors for Uncontrolled Industrial Boilers Firing Distillate Oil."
   d. Table 1.3-3 "Emission Factors for Total Organic Compounds (TOC), Methane, and Nonmethane TOC (NMTOC) From Uncontrolled Fuel Oil Combustion."
2. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

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Camp Ravenna Joint Military Training Center (CRJMTC)

Expedited Schedule

Calculate Annual Fuel Usage for Fuel Storage Tanks During Operations

Fuel Tank Diameter [(1)] (ft)	Fuel Tank Length [(1)] (ft)	Type of Fuel Tank [(2)]	Fuel Tank Capacity [(2)] (gal)	Number of Tanks [(2)]	Number of RICE Engines	Hours Per Year of RICE Engines [(3)]	Fuel Consumption Rate [(4)] (gal/hr)	Annual Fuel Consumption (gal/yr)	Annual Tank Turnovers
5.42	9	Vertical	1,500	4	4	500	210.7	421,400	280.93
10	51	Horizontal	30,000	3	4	500	210.7	421,400	14.05

Notes [ ]:

1. The fuel tank diameter and length were estimated using the National Board Standards from Engineering Toolbox Website (http://www.engineeringtoolbox.com/fuel-oil-storage-tanks-dimensions-d_1585.html). These numbers are used as input into the USAF's ACAM model to estimate VOC emissions from the fuel storage tanks.
2. The potential fuel storage tank parameters (i.e., type, number, and capacity) are based on information contained in the potential CIS deployment's Chapter 2.3 of the EIS.
3. The emission analysis for the backup RICE engines assumes that the engines will operate 500 hours or less per year.
4. Fuel consumption rates are based on the manufacturer's specifications for a Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum operating at maximum load.

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Camp Ravenna Joint Military Training Center (CRJMTC)

Expedited Schedule

Air Emissions Estimate for Fuel Storage Tanks During Operations

Emission Activity	Estimated Annual Air Emissions (tons/year) [1]													
	Year 4							Year 5						
	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Fuel Storage Tanks	0.016	0	0	0	0	0	0	0.064	0	0	0	0	0	0

Notes [ ]:

1. The fuel storage tanks will emit VOC's during operations. The amount of VOC's emitted was estimated using the USAF's ACAM model (Version 5.02) using as input the dimensions of the tank and the amount of turnovers per year for each tank.

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Camp Ravenna Joint Military Training Center (CRJMTC)

Expedited Schedule

Air Emissions Estimate for Worker Vehicles During Operations

Vehicle Type [(1)]	Trips/ Day [(2)]	Days/Year [(3)]		Miles/ Trip [(4)]	Emission Factor (g/mi) [(5)]							Estimated Annual Air Emissions (tons/year) [(6)] Year 4							Year 5						
		Year 4	Year 5		VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Passenger Car	425	92	365	50	0.319	3.516	0.009	0.008	0.250	336.54	0.002	0.69	7.58	0.02	0.02	0.54	658	0.004	2.73	30.06	0.08	0.07	2.14	2,610	0.017
Light Duty Truck	425	92	365	50	0.401	4.907	0.012	0.010	0.432	433.17	0.003	0.86	10.57	0.03	0.02	0.93	847	0.006	3.43	41.95	0.10	0.09	3.69	3359.77	0.026
											Total Annual Emission	1.55	18.15	0.05	0.04	1.47	1,505	0.011	6.16	72.01	0.18	0.15	5.83	5,970	0.043

Notes [ ]:

1. It is assumed that the fleet of worker vehicles will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
2. Trips per day is based on the maximum number of workers during operation of the potential CIS deployment as listed in Chapter 2 of the EIS. A maximum of 850 workers are expected daily which is split between the two vehicle types. The workers include military, civilian, and contractor support maintenance personnel.
3. Days per year assumes that the potential CIS deployment will require workers traveling to the site each day of the year. It is assumed that operations will start during October of Year 4.
4. Total miles/trip is a roundtrip distance traveled by the worker vehicles to account for indirect emissions during operation of the potential CIS deployment.
5. The emission factors are from the United States Air Force (USAF) Air Conformity Applicability Model (ACAM). The ACAM model emission factors are derived from the United States Environmental Protection Agency (USEPA) Motor Vehicle Emission Simulator (MOVES) computer model. Emission Factors are for 2019 and are used for Years 4 and 5.
6. The total annual emissions for CO_2 emission is in units of metric tons per year. The total annual emissions for VOC, CO, PM_{10}, $PM_{2.5}$, NO_x, and SO_2 is provided in units of tons per year.

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Camp Ravenna Joint Military Training Center (CRJMTC)

Expedited Schedule

Summary of Air Emissions Estimate During Operation of the Potential CIS Deployment

Pollutant	Estimated Annual Emissions (ton/year) (1)	
	Year 4	Year 5
NO_X	13.2	52.6
VOC	12.2	48.6
SO_2	0.03	0.13
$PM_{2.5}$	0.4	1.6
PM_{10}	0.5	1.9
CO	24.2	96.3
GHG - CO_{2e} Basis	3,714	14,805

Notes [ ]:

1. The air emissions of carbon dioxide equivalents (CO_2e) are provided in metric tons per year. The air emissions of criteria pollutants are provided in tons per year.

APPENDIX D.4

FTD Site

Air Quality Calculations

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Construction – Baseline Schedule

FTD Training Range Site 7

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FCTC Site 2 Construction CO_2 Emission Calculations

Expedited Schedule

Annual Emission Factors		Year 2	Year 3	Year 4
		Emission Factors [1] (lb/hr)		
Activity	Construction Equipment Name	CO2	CO2	CO2
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54
	Rubber Tire Loaders Composite	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.57	119.57	119.57
	Graders Composite	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other Material Handling Equipment Composite	141.19	141.19	141.19
	Rollers Composite	67.046	67.046	67.046
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.87	164.87	164.87
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74
	Other Construction Equipment Composite	122.50	122.50	122.50
	Rollers Composite	67.042	67.042	67.042

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.02 program.

Annual Estimated Emissions							Year 2	Year 3	Year 4
Activity	Construction Equipment Name[1]	Number of Equipment Pieces[2]	Year 2 Days/yr[3]	Year 3 Days/yr[3]	Year 4 Days/yr[3]	Equipment Use (hpd)[4]	Metric Tons CO2	Metric Tons CO2	Metric Tons CO2
Tree Clearing (Months 4-7)	Air Compressors Composite	3	120	0	0	6.28	65.228	0.000	0.000
	Crawler Tractors Composite	4	120	0	0	6.08	150.923	0.000	0.000
	Crushing/Proc Equipment Composite	2	120	0	0	6.42	92.464	0.000	0.000
	Excavators Composite	4	120	0	0	12.44	323.882	0.000	0.000
	Off-Highway Trucks	1	120	0	0	0.02	0.283	0.000	0.000
	Other Construction Equipment Composite	1	120	0	0	0.60	4.002	0.000	0.000
	Rubber Tire Loaders Composite	2	120	0	0	3.72	43.984	0.000	0.000
Site Prep (Months 8-14)	Air Compressors Composite	3	214	0	0	6.28	116.323	0.000	0.000
	Bore/Drill Rigs Composite	2	214	0	0	0.84	26.891	0.000	0.000
	Crawler Tractors Composite	7	214	0	0	6.08	471.004	0.000	0.000
	Crushing/Proc Equipment Composite	1	214	0	0	6.42	82.447	0.000	0.000
	Excavators Composite	21	214	0	0	12.44	3032.089	0.000	0.000
	Graders Composite	1	214	0	0	11.18	144.053	0.000	0.000
	Off-Highway Trucks	1	214	0	0	0.02	0.505	0.000	0.000
	Other Construction Equipment Composite	1	214	0	0	0.60	7.137	0.000	0.000
	Other Material Handling Equipment Composite	3	214	0	0	6.48	266.428	0.000	0.000
	Rollers Composite	16	214	0	0	17.14	1784.776	0.000	0.000
	Rubber Tire Loaders Composite	2	214	0	0	3.72	78.437	0.000	0.000
	Scrapers Composite	1	214	0	0	17.32	441.290	0.000	0.000
	Trenchers Composite	1	214	0	0	4.36	24.849	0.000	0.000
Construction (Months 15-29)	Aerial Lifts Composite	4	31	365	59	6.56	12.811	150.840	24.382
	Air Compressors Composite	5	31	365	59	12.62	56.437	664.498	107.412
	Bore/Drill Rigs Composite	1	31	365	59	4.50	10.434	122.847	19.858
	Concrete and Mortar Mixers	1	31	365	59	1.14	0.116	1.368	0.221
	Concrete/Industrial Saws Composite	1	31	365	59	2.26	1.858	21.875	3.536
	Cranes	21	31	365	59	4.30	163.314	1922.894	310.824
	Crawler Tractors Composite	11	31	365	59	8.32	146.719	1727.500	279.240
	Excavators Composite	1	31	365	59	0.94	1.580	18.608	3.008
	Generator Sets Composite	1	31	365	59	4.78	4.099	48.268	7.802
	Other Construction Equipment Composite	11	31	365	59	3.74	70.888	834.644	134.915
	Other General Industrial Equipment Composite	1	31	365	59	4.78	10.232	120.472	19.474
	Paving Equipment Composite	8	31	365	59	3.24	25.127	295.846	47.822
	Plate Compactors Composite	4	31	365	59	3.78	0.917	10.799	1.746
	Pumps Composite	12	31	365	59	12.10	101.281	1192.504	192.761
	Rubber Tire Loaders Composite	16	31	365	59	6.96	170.070	2002.434	323.681
	Surfacing Equipment Composite	1	31	365	59	3.54	8.261	97.267	15.723
	Tractors/Loaders/Backhoes Composite	2	31	365	59	1.72	3.231	38.043	6.149
	Trenchers Composite	1	31	365	59	0.10	0.083	0.972	0.157
	Welders Composite	22	31	365	59	17.76	140.659	1656.146	267.706
1-Mo Construction (Month 23)	Paving Composite	5	0	31	0	9.18	0.000	44.495	0.000
Buildout (Months 30-36)	Bore/Drill Rigs Composite	8	0	0	214	15.84	0.000	0.000	2027.995
	Crushing/Proc Equipment Composite	1	0	0	214	1.24	0.000	0.000	15.924
	Graders Composite	1	0	0	214	2.62	0.000	0.000	33.758
	Other Construction Equipment Composite	2	0	0	214	0.28	0.000	0.000	6.659
	Rollers Composite	6	0	0	214	4.50	0.000	0.000	175.708
							Year 2	Year 3	Year 4
Total CO2 Tons Emissions from Construction Equipment							8,085.11	10,972.32	4,026.46

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.
2. The analysis assumes that construction will occur every day of the month.
3. Total days per year was determined by the construction schedule working 7 days a week per the EIS construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1.

4. The number of equipment pieces assumes the same quantities used in the baseline construction schedule, but the hours per day are double the hours used in the baseline construction schedule.

FCTC Site 2 Construction Worker Vehicle Estimated Emissions

Expedited Schedule

Air Emissions Estimate for Worker Vehicles during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.429	0.011	0.013	0.372	4.342	351.890	0.002	0.385	0.010	0.011	0.319	4.071	343.442	0.002	0.347	0.009	0.010	0.274	3.825	334.459	0.002
Light-Duty Trucks	0.559	0.013	0.015	0.636	6.358	457.034	0.003	0.496	0.012	0.014	0.549	5.830	443.649	0.003	0.443	0.011	0.013	0.475	5.362	430.939	0.003

Estimated Annual Air Emissions: Jan - Apr. Year 2 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	120	0	0	100	0	0	0.2837	0.0073	0.0086	0.2460	2.8717	211.134	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	50	120	0	0	100	0	0	0.3697	0.0086	0.0099	0.4206	4.2051	274.22	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
		Total Annual Emissions from Worker Vehicles						**0.6535**	**0.0159**	**0.0185**	**0.6667**	**7.0768**	**485.35**	**0.0033**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**

Estimated Annual Air Emissions: May - Nov. Year 2, Mar - Sep. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	214	0	214	400	0	400	2.0240	0.0519	0.0613	1.7551	20.4851	1506.09	0.0094	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.6371	0.0425	0.0472	1.2927	18.0459	1431.48	0.0094
Light-Duty Trucks	50	214	0	214	400	0	400	2.6373	0.0613	0.0708	3.0006	29.9964	1956.11	0.0142	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	2.0900	0.0519	0.0613	2.2410	25.2973	1844.42	0.0142
		Total Annual Emissions from Worker Vehicles						**4.6613**	**0.1132**	**0.1321**	**4.7556**	**50.4815**	**3462.19**	**0.0236**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**3.7271**	**0.0944**	**0.1085**	**3.5337**	**43.3433**	**3275.90**	**0.0236**

Estimated Annual Air Emissions: Dec. Year 2 - Feb. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	31	365	59	600	600	600	0.4398	0.0113	0.0133	0.3814	4.4512	327.258	0.0021	4.6471	0.1207	0.1328	3.8504	49.1382	3760.69	0.0241	0.6770	0.0176	0.0195	0.5346	7.4629	591.99	0.0039
Light-Duty Trucks	50	31	365	59	600	600	600	0.5731	0.0133	0.0154	0.6520	6.5179	425.04	0.0031	5.9869	0.1448	0.1690	6.6266	70.3699	4857.96	0.0362	0.8643	0.0215	0.0254	0.9268	10.4618	762.76	0.0059
		Total Annual Emissions from Worker Vehicles						**1.0128**	**0.0246**	**0.0287**	**1.0334**	**10.9691**	**752.30**	**0.0051**	**10.6339**	**0.2655**	**0.3018**	**10.4770**	**119.51**	**8618.65**	**0.0604**	**1.5414**	**0.0390**	**0.0449**	**1.4614**	**17.925**	**1354.75**	**0.0098**

Notes [ ]:

1. Kalamazoo County emission factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4. The expedited construction schedule will occur during Years 2-4.

2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.

3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling to and from the FCTC Site 2.
4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.

5. Trips/Day are based on monthly project estimates for the expected distribution of workers averaged over each year of the expected construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1. The analysis uses 200 workers during months 4-7 starting in January of Year 2, 800 construction workers during months 8-14 starting in May of Year 2, 1200 workers during months 15-29 starting December of Year 2, and 800 construction workers during months 30-36 starting in March of Year 4.
6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 2 On-Road Haul/Delivery Truck Estimated Emissions

Expedited Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.639	0.238	0.259	6.682	2.181	1523.74	0.013	0.583	0.206	0.224	6.048	2.008	1509.30	0.013	0.535	0.179	0.195	5.489	1.858	1495.96	0.013

Estimated Annual Air Emissions (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	20	365	365	273	90	90	90	0.4628	0.1724	0.1876	4.8392	1.5795	#######	0.0094	0.4222	0.1492	0.1622	4.3801	1.4542	991.607	0.0094	0.2898	0.0970	0.1056	2.9733	1.0064	735.112	0.0070
		Total Annual Emissions from Haul/Delivery Trucks						**0.4628**	**0.1724**	**0.1876**	**4.8392**	**1.5795**	**1001.10**	**0.0094**	**0.4222**	**0.1492**	**0.1622**	**4.3801**	**1.4542**	**991.61**	**0.0094**	**0.2898**	**0.0970**	**0.1056**	**2.9733**	**1.0064**	**735.11**	**0.0070**

Notes [ ]:

1. Kalamazoo County emission factors for Heavy Duty Diesel Vehicles (HDDV) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the FCTC Site 2 site to an off base location.
4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are assumed for all years of construction. It is assumed that the on road haul/delivery trucks will be used to removed construction waste from the site, remove cut from or deliver fill to the site, deliver construction materials to the site, and other types of activities during construction.
6. It is assumed that the final design would be completed and required permits would be obtained in Year 1. Tree clearing is expected to start in January of Year 2 to April of Year 2. Site preparation is expected to take place starting in May of Year 2 through November of Year 2. Heavy construction is expected to start in December of Year 2 through February of Year 4. Buildout is expected to start in March of Year 4 through September of Year 4.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FCTC Site 2 Total Emissions

Expedited Schedule

FCTC Site 2 Estimated Air Emissions During Construction

Pollutant	Construction Equipment Emissions [1] (ton/yr)	Worker Vehicle Emissions [2] (ton/yr)	On-Road Haul/Delivery Truck Emissions [3] (ton/yr)	TOTAL Annual Emissions (ton/yr)
Year 2				
VOC	7.71	6.33	0.46	14.50
NO_X	51.36	6.46	4.84	62.66
SO_X	1.409	0.032	0.009	1.450
$PM_{2.5}$	2.84	0.15	0.17	3.17
PM_{10}	3,459.80	0.18	0.19	3,460.17
CO	39.55	68.53	1.58	109.66
CO_2e [4]	8,085.11	4,699.85	1,001.10	13,786.06
Year 3				
VOC	13.80	10.63	0.42	24.85
NO_X	90.65	10.48	4.38	105.50
SO_X	15.980	0.060	0.009	16.050
$PM_{2.5}$	5.10	0.27	0.15	5.51
PM_{10}	1,733.58	0.30	0.16	1,734.04
CO	65.38	119.51	1.45	186.34
CO_2e [4]	10,972.32	8,618.65	991.61	20,582.57
Year 4				
VOC	2.54	5.27	0.29	8.10
NO_X	17.17	5.00	2.97	25.13
SO_X	2.679	0.033	0.007	2.719
$PM_{2.5}$	0.82	0.13	0.10	1.05
PM_{10}	0.82	0.15	0.11	1.08
CO	15.09	61.27	1.01	77.36
CO_2e [4]	4,026.46	4,630.66	735.11	9,392.23

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculated in the tabs on this spreadsheet using emission factors from ACAM 5.02 and is given in metric tons.

Construction – Expedited Schedule

FTD Training Range Site 7

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FTD Training Range Site 7 Construction CO2 Emission Calculations

Expedited Schedule

Annual Emission Factors		Year 2	Year 3	Year 4
		Emission Factors [1] (lb/hr)		
Activity	**Construction Equipment Name**	**CO2**	**CO2**	**CO2**
Tree Clearing	Air Compressors Composite	63.607	63.607	63.607
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.56	122.56	122.56
	Rubber Tire Loaders Composite	108.61	108.61	108.61
Site Prep	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.9	164.9	164.9
	Crawler Tractors Composite	114.01	114.01	114.01
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Excavators Composite	119.58	119.58	119.58
	Graders Composite	132.74	132.74	132.74
	Off-Highway Trucks	260.05	260.05	260.05
	Other Construction Equipment Composite	122.56	122.56	122.56
	Other Material Handling Equipment Composite	141.19	141.19	141.19
	Rollers Composite	67.048	67.048	67.048
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Scrapers Composite	262.48	262.48	262.48
	Trenchers Composite	58.714	58.714	58.714
Construction	Aerial Lifts Composite	34.721	34.721	34.721
	Air Compressors Composite	63.607	63.607	63.607
	Bore/Drill Rigs Composite	164.89	164.89	164.89
	Concrete and Mortar Mixers	7.2481	7.2481	7.2481
	Concrete/Industrial Saws Composite	58.463	58.463	58.463
	Cranes	128.62	128.62	128.62
	Crawler Tractors Composite	114.01	114.01	114.01
	Excavators Composite	119.57	119.57	119.57
	Generator Sets Composite	60.992	60.992	60.992
	Other Construction Equipment Composite	122.54	122.54	122.54
	Other General Industrial Equipment Composite	152.23	152.23	152.23
	Paving Equipment Composite	68.94	68.94	68.94
	Plate Compactors Composite	4.3138	4.3138	4.3138
	Pumps Composite	49.606	49.606	49.606
	Rubber Tire Loaders Composite	108.61	108.61	108.61
	Surfacing Equipment Composite	165.96	165.96	165.96
	Tractors/Loaders/Backhoes Composite	66.797	66.797	66.797
	Trenchers Composite	58.714	58.714	58.714
	Welders Composite	25.602	25.602	25.602
1-Mo Construction	Paving Equipment Composite	68.94	68.94	68.94
Buildout	Bore/Drill Rigs Composite	164.89	164.89	164.89
	Crushing/Proc Equipment Composite	132.3	132.3	132.3
	Graders Composite	132.74	132.74	132.74
	Other Construction Equipment Composite	122.54	122.54	122.54
	Rollers Composite	67.048	67.048	67.048

Notes:

1. Emission Factors are specific to the piece of equipment from ACAM 5.02 program.

Annual Estimated Emissions							Year 2	Year 3	Year 4
Activity	**Construction Equipment Name** [1]	**Number of Equipment Pieces** [2]	**Year 2 Days/yr** [3]	**Year 3 Days/yr** [3]	**Year 4 Days/yr** [3]	**Equipment Use (hpd)** [4]	**Metric Tons CO2**	**Metric Tons CO2**	**Metric Tons CO2**
Tree Clearing (Months 4-7)	Air Compressors Composite	3	120	0	0	6.28	65.228	0.000	0.000
	Crawler Tractors Composite	4	120	0	0	6.08	150.923	0.000	0.000
	Crushing/Proc Equipment Composite	2	120	0	0	6.42	92.464	0.000	0.000
	Excavators Composite	4	120	0	0	12.44	323.882	0.000	0.000
	Off-Highway Trucks	1	120	0	0	0.02	0.283	0.000	0.000
	Other Construction Equipment Composite	1	120	0	0	0.60	4.003	0.000	0.000
	Rubber Tire Loaders Composite	2	120	0	0	3.72	43.984	0.000	0.000
Site Prep (Months 8-14)	Air Compressors Composite	3	214	0	0	6.28	116.323	0.000	0.000
	Bore/Drill Rigs Composite	2	214	0	0	0.84	26.891	0.000	0.000
	Crawler Tractors Composite	7	214	0	0	6.08	471.004	0.000	0.000
	Crushing/Proc Equipment Composite	1	214	0	0	6.42	82.447	0.000	0.000
	Excavators Composite	21	214	0	0	12.44	3032.343	0.000	0.000
	Graders Composite	1	214	0	0	11.18	144.053	0.000	0.000
	Off-Highway Trucks	1	214	0	0	0.02	0.505	0.000	0.000
	Other Construction Equipment Composite	1	214	0	0	0.60	7.138	0.000	0.000
	Other Material Handling Equipment Composite	3	214	0	0	6.48	266.428	0.000	0.000
	Rollers Composite	16	214	0	0	17.14	1784.829	0.000	0.000
	Rubber Tire Loaders Composite	2	214	0	0	3.72	78.437	0.000	0.000
	Scrapers Composite	1	214	0	0	17.32	441.290	0.000	0.000
	Trenchers Composite	1	214	0	0	4.36	24.849	0.000	0.000
Construction (Months 15-29)	Aerial Lifts Composite	4	31	365	59	6.56	12.811	150.840	24.382
	Air Compressors Composite	5	31	365	59	12.62	56.437	664.498	107.412
	Bore/Drill Rigs Composite	1	31	365	59	4.50	10.434	122.847	19.858
	Concrete and Mortar Mixers	1	31	365	59	1.14	0.116	1.368	0.221
	Concrete/Industrial Saws Composite	1	31	365	59	2.26	1.858	21.875	3.536
	Cranes	21	31	365	59	4.30	163.314	1922.894	310.824
	Crawler Tractors Composite	11	31	365	59	8.32	146.719	1727.500	279.240
	Excavators Composite	1	31	365	59	0.94	1.580	18.608	3.008
	Generator Sets Composite	1	31	365	59	4.78	4.099	48.268	7.802
	Other Construction Equipment Composite	11	31	365	59	3.74	70.888	834.644	134.915
	Other General Industrial Equipment Composite	1	31	365	59	4.78	10.232	120.472	19.474
	Paving Equipment Composite	8	31	365	59	3.24	25.127	295.846	47.822
	Plate Compactors Composite	4	31	365	59	3.78	0.917	10.799	1.746
	Pumps Composite	12	31	365	59	12.10	101.281	1192.504	192.761
	Rubber Tire Loaders Composite	16	31	365	59	6.96	170.070	2002.434	323.681
	Surfacing Equipment Composite	1	31	365	59	3.54	8.261	97.267	15.723
	Tractors/Loaders/Backhoes Composite	2	31	365	59	1.72	3.231	38.043	6.149
	Trenchers Composite	1	31	365	59	0.10	0.083	0.972	0.157
	Welders Composite	22	31	365	59	17.76	140.659	1656.146	267.706
1-Mo Construction (Month 23)	Paving Composite	5	0	31	0	9.18	0.000	44.495	0.000
Buildout (Months 30-36)	Bore/Drill Rigs Composite	8	0	0	214	15.84	0.000	0.000	2028.241
	Crushing/Proc Equipment Composite	1	0	0	214	1.24	0.000	0.000	15.924
	Graders Composite	1	0	0	214	2.62	0.000	0.000	33.758
	Other Construction Equipment Composite	2	0	0	214	0.28	0.000	0.000	6.661
	Rollers Composite	6	0	0	214	4.50	0.000	0.000	175.723
							Year 2	**Year 3**	**Year 4**
Total CO2 Tons Emissions from Construction Equipment							**8,085.42**	**10,972.32**	**4,026.72**

Notes:

1. The construction equipment list is based on previous MDA projects similar to the potential CIS deployment. The construction equipment names were determined by comparing the list with the available list of construction equipment within the ACAM 5.02 model.

2. The analysis assumes that construction will occur every day of the month.

3. Total days per year was determined by the construction schedule working 7 days a week per the EIS construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1.

4. The number of equipment pieces assumes the same quantities used in the baseline construction schedule, but the hours per day are double the hours used in the baseline construction schedule.

FTD Training Range Site 7 Construction Worker Vehicle Estimated Emissions

Expedited Schedule

Air Emissions Estimate for Worker Vehicles during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
Passenger Cars	0.356	0.010	0.011	0.302	3.506	351.913	0.002	0.321	0.009	0.010	0.259	3.302	343.448	0.002	0.291	0.008	0.009	0.223	3.115	334.446	0.002
Light-Duty Trucks	0.423	0.012	0.014	0.511	4.903	457.648	0.003	0.380	0.011	0.013	0.442	4.530	444.225	0.003	0.342	0.010	0.012	0.382	4.192	431.478	0.003

Estimated Annual Air Emissions: Jan - Apr. Year 2 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	120	0	0	100	0	0	0.2355	0.0066	0.0073	0.1997	2.3188	211.148	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000	0.0000
Light-Duty Trucks	50	120	0	0	100	0	0	0.2798	0.0079	0.0093	0.3380	3.2428	274.59	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000
		Total Annual Emissions from Worker Vehicles						**0.5152**	**0.0146**	**0.0165**	**0.5377**	**5.5616**	**485.74**	**0.0033**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**

Estimated Annual Air Emissions: May - Nov. Year 2, Mar - Sep. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	214	0	214	400	0	400	1.6796	0.0472	0.0519	1.4248	16.5409	1506.19	0.0094	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.3729	0.0377	0.0425	1.0521	14.6962	1431.43	0.0094
Light-Duty Trucks	50	214	0	214	400	0	400	1.9957	0.0566	0.0661	2.4108	23.1318	1958.73	0.0142	0.0000	0.0000	0.0000	0.0000	0.0000	0.00	0.0000	1.6135	0.0472	0.0566	1.8022	19.7774	1846.73	0.0142
		Total Annual Emissions from Worker Vehicles						**3.6752**	**0.1038**	**0.1179**	**3.8356**	**39.6728**	**3464.92**	**0.0236**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.00**	**0.0000**	**2.9864**	**0.0849**	**0.0991**	**2.8543**	**34.4736**	**3278.15**	**0.0236**

Estimated Annual Air Emissions: Dec. Year 2 - Feb. Year 4 (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
Passenger Cars	50	31	365	59	600	600	600	0.3650	0.0103	0.0113	0.3096	3.5942	327.279	0.0021	3.8746	0.1086	0.1207	3.1262	39.8562	3760.76	0.0241	0.5678	0.0156	0.0176	0.4351	6.0776	591.97	0.0039
Light-Duty Trucks	50	31	365	59	600	600	600	0.4336	0.0123	0.0144	0.5239	5.0263	425.61	0.0031	4.5867	0.1328	0.1569	5.3351	54.6785	4864.26	0.0362	0.6673	0.0195	0.0234	0.7453	8.1790	763.72	0.0059
		Total Annual Emissions from Worker Vehicles						**0.7986**	**0.0226**	**0.0256**	**0.8334**	**8.6205**	**752.89**	**0.0051**	**8.4613**	**0.2414**	**0.2776**	**8.4613**	**94.53**	**8625.02**	**0.0604**	**1.2350**	**0.0351**	**0.0410**	**1.1804**	**14.257**	**1355.69**	**0.0098**

Notes [ ]:

1. Jefferson County emission Factors for Passenger Car (LDGV) and Light-Duty Gasoline Truck (LDGT All) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4. The expedited construction schedule will occur during Years 2-4.

2. This table provides annual emission factors for construction worker vehicles during each year of construction of the potential CIS deployment.

3. Total miles/trip is based on a roundtrip commuting distance of 50 miles for construction worker vehicles traveling to and from the FTD Training Range Site 7.

4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.

5. Trips/Day are based on monthly project estimates for the expected distribution of workers averaged over each year of the expected construction schedule. It is assumed that the final design would be completed and required permits would be obtained in Year 1. The analysis uses 200 workers during months 4-7 starting in January of Year 2, 800 construction workers during months 8-14 starting in May of Year 2, 1200 workers during months 15-29 starting December of Year 2, and 800 construction workers during months 30-36 starting in March of Year 4.

6. It is assumed that the fleet of worker vehicles during construction will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.

7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FTD Training Range Site 7 On-Road Haul/Delivery Truck Estimated Emissions

Expedited Schedule

Air Emissions Estimate for On-Road Haul/Delivery Trucks during Construction

Annual Emission Factors[1, 2] (g/mi)

Vehicle Type	Year 2							Year 3							Year 4						
	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2	VOC	$PM_{2.5}$	PM_{10}	NOx	CO	CO_2	SO_2
HDDV	0.533	0.234	0.255	6.053	1.970	1499.03	0.013	0.482	0.202	0.220	5.438	1.798	1485.24	0.013	0.438	0.176	0.191	4.898	1.648	1472.51	0.013

Estimated Annual Air Emissions (tons/year)

Vehicle Type	Miles/ Trip[3]	Days/Year[4]			Trips/Day [5,6]			Year 2							Year 3							Year 4						
		Year 2	Year 3	Year 4	Year 2	Year 3	Year 4	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2	VOC	$PM_{2.5}$	PM_{10}	NO_x	CO	CO_2 [7]	SO_2
HDDV	20	365	365	273	90	90	90	0.3860	0.1695	0.1847	4.3837	1.4267	984.861	0.0094	0.3491	0.1463	0.1593	3.9383	1.3021	975.805	0.0094	0.2373	0.0953	0.1035	2.6531	0.8927	723.590	0.0070
		Total Annual Emissions from Haul/Delivery Trucks						**0.3860**	**0.1695**	**0.1847**	**4.3837**	**1.4267**	**984.86**	**0.0094**	**0.3491**	**0.1463**	**0.1593**	**3.9383**	**1.3021**	**975.81**	**0.0094**	**0.2373**	**0.0953**	**0.1035**	**2.6531**	**0.8927**	**723.59**	**0.0070**

Notes [ ]:

1. Jefferson County emission Factors for Heavy Duty Diesel Vehicles (HDDV) are from USAF 's ACAM model. The ACAM model utilizes emission factors for mobile vehicles that is based on the US EPA's MOVES program. The assumptions for the analysis is that 2017 emission factors are used for Year 2, 2018 for Year 3, and 2019 for Year 4.
2. This table provides annual emission factors for on-road heavy duty trucks during each year of construction of the potential CIS deployment.
3. Total miles/trip is based on a roundtrip distance of 20 miles from the FTD Training Range Site 7 site to an off base location.
4. It is assumed that workers will work seven days per week with the expedited schedule. Construction will occur all year during Years 2 and 3 and 9 months in Year 4.
5. The trips per day are based on monthly project estimates for the expected distribution of on-road truck averaged over each year of the construction schedule. Ninety truck trips per day are assumed for all years of construction. It is assumed that the on road haul/delivery trucks will be used to removed construction waste from the site, remove cut from or deliver fill to the site, deliver construction materials to the site, and other types of activities during construction.
6. It is assumed that the final design would be completed and required permits would be obtained in Year 1. Tree clearing is expected to start in January of Year 2 to April of Year 2. Site preparation is expected to take place starting in May of Year 2 through November of Year 2. Heavy construction is expected to start in December of Year 2 through February of Year 4. Buildout is expected to start in March of Year 4 through September of Year 4.
7. Maximum estimated emissions for CO_2 is provided in units of metric tons. All other criteria pollutants is provided in units of tons.

FTD Training Range Site 7 Total Emissions

Expedited Schedule

FTD Training Range Site 7 Estimated Air Emissions During Construction

Year 2				
Pollutant	**Construction Equipment Emissions (1) (ton/yr)**	**Worker Vehicle Emissions (2) (ton/yr)**	**On-Road Haul/Delivery Truck Emissions (3) (ton/yr)**	**TOTAL Annual Emissions (ton/yr)**
VOC	7.71	4.99	0.39	13.1
NO_X	51.36	5.21	4.38	61.0
SO_X	1.409	0.032	0.009	1.45
$PM_{2.5}$	2.84	0.14	0.17	3.2
PM_{10}	4,146.20	0.16	0.18	4,146.5
CO	39.55	53.85	1.43	94.8
CO_2e (4)	8,085	4,704	985	13,774

Year 3				
Pollutant	**Construction Equipment Emissions (1) (ton/yr)**	**Worker Vehicle Emissions (2) (ton/yr)**	**On-Road Haul/Delivery Truck Emissions (3) (ton/yr)**	**TOTAL Annual Emissions (ton/yr)**
VOC	13.80	8.46	0.35	22.6
NO_X	90.65	8.46	3.94	103.0
SO_X	15.980	0.060	0.009	16.05
$PM_{2.5}$	5.10	0.24	0.15	5.5
PM_{10}	2,076.78	0.28	0.16	2,077.2
CO	65.38	94.53	1.30	161.2
CO_2e (4)	10,972	8,625	976	20,573

Year 4				
Pollutant	**Construction Equipment Emissions (1) (ton/yr)**	**Worker Vehicle Emissions (2) (ton/yr)**	**On-Road Haul/Delivery Truck Emissions (3) (ton/yr)**	**TOTAL Annual Emissions (ton/yr)**
VOC	2.54	4.22	0.24	7.0
NO_X	17.17	4.03	2.65	23.9
SO_X	2.679	0.033	0.007	2.72
$PM_{2.5}$	0.82	0.12	0.10	1.0
PM_{10}	0.82	0.14	0.10	1.1
CO	15.09	48.73	0.89	64.7
CO_2e (4)	4,027	4,634	724	9,384

Notes:

1. The construction equipment emissions for each criteria pollutant is based on output from the United States Air Force Air Conformity Applicability Model (ACAM), Version 5.02.
2. Criteria pollutant emissions were calculated in the Construction Worker Vehicle sheet using emission factors from ACAM 5.02
3. Criteria pollutant emissions were calculated in the OnRoad Haul-Delivery Truck sheet using emission factors from ACAM 5.02.
4. CO_2 was calculated in the tabs on this spreadsheet using emission factors from ACAM 5.02 and is given in metric tons.

Operation – Baseline Schedule

FTD Training Range Site 7

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Fort Drum (FTD) Training Range Site 7

Baseline Schedule

Air Emissions Estimate for Power Plant Generators

Basis:

Number of Units	4	
Fuel	Diesel Fuel Oil	
Power Rating	3,000	kW
Heat Input	28.87	mmBtu/hr
Heating Value of Fuel	137,000	Btu/gal [2]
Fuel Burn Rate	211	gal/hr [1]
Hours of Operation	500	hours per year
Density of Fuel	7.05	lb/gal [2]
Sulfur Content of Fuel	0.0015	% [3]

Global Warming Potentials [4]

CO_2	1
CH_4	25
N_2O	298

Pollutant	Mass Emission Rate				Annual Emissions (tpy)	
	g/kw-hr	lb/mmBtu	Notes	lb/hr	Year 6	Year 7
CO	3.50		[8]	23.15	17.36	23.15
NO_X	6.40		[8]	42.33	31.75	42.33
PM	0.20		[8]	1.32	0.99	1.32
PM_{10}	0.20		[5]	1.32	0.99	1.32
$PM_{2.5}$	0.20		[5]	1.32	0.99	1.32
SO_2	0.0067		[6]	0.045	0.033	0.045
VOC	6.40		[8,9]	42.33	31.75	42.33
GHG-Mass	--	--	[8]	4,707	3,530	4,707
CO_2	--	1.63E+02	[10]	4,706.70	3,530	4,707
CH_4	--	6.61E-03	[10]	0.19	0.14	0.19
N_2O	--	1.32E-03	[10]	3.82E-02	0.03	0.04
GHG-CO2e	--		[7]	4,723	3,213	4,284
CO_2	--		[4]	4,707	3,202	4,270
CH_4	--		[4]	4.77	3.25	4.33
N_2O	--		[4]	11.4	7.74	10.32

Notes [ ]:

1. Based on manufacturer's specifications for Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum power rating.
2. Based on diesel fuel characteristics listed in Reference 1.
3. Based on the requirements of 40 CFR Part 63, Subpart ZZZZ and 40 CFR Part 80.510(b).
4. CO_2 equivalents (CO_2e) provided in metric tons based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
5. It is assumed that the PM_{10} and $PM_{2.5}$ emission factors are the same as PM.
6. Assumed all sulfur in the fuel is converted to SO_2.
7. The GHG emissions is the sum of all applicable GHG pollutants.
8. Emission limits for Tier II engine manufactured after 2010 and >900 kW - 40 CFR §89.112(a), Table 1.
9. Emission limit provided by Tier II standards is for NO_X+NMHC. Engine VOC emissions were conservatively assumed to be equal to the entire emission limit of 6.4 g/kW-hr.
10. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

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Fort Drum (FTD) Training Range Site 7
Baseline Schedule
Air Emissions Estimate for 7 MMBtu/hr Boilers

Basis:

Number of Boilers	1	
Fuel	Diesel Fuel Oil	

Boiler Information

Heat Input	7.0	MMBtu/hr [1]
Heating Value of Fuel	137,000	Btu/gal[2]
Fuel Burn Rate	51	gal/hr
Hours of Operation (Per Boiler)	8,760	hours per year
Annual Fuel Usage (Cumulative)	447,591	gal/year
Sulfur Content of Fuel	0.0015	%

Miscellaneous Data

Density of Fuel Oil	7.05	lb/gal[2]
SO_2 to SO_3 Conversion Rate	100	% by volume (assumed)
Molecular Weight of Sulfur	32	lb/lb-mol
Molecular Weight of Oxygen	16	lb/lb-mol
Molecular Weight of Hydrogen	1	lb/lb-mol

Global Warming Potentials [10]	
CO_2	1
CH_4	25
N_2O	298

Boiler Emissions Summary

Pollutant	Mass Emission Rate (per unit)				Annual Emissions (tpy)	
	(lb/gal)	(lb/MMBtu)	Notes	(lb/hr)	Year 6 [11]	Year 7 [12]
CO	0.005	0.036	[5]	0.26	0.84	1.12
NO_X	0.02	0.146	[5]	1.02	3.36	4.48
PM (total)	0.0033	0.0241	[2,3,5]	0.169	0.55	0.74
PM (filterable)	0.0020	0.0146	[2,3,5]	0.102	0.34	0.45
PM (condensable)	0.0013	0.0095	[2,3]	0.066	0.22	0.29
PM_{10}		0.012	[7]	0.08	0.28	0.37
$PM_{2.5}$		0.003	[7]	0.020	0.07	0.09
SO_2	2.12E-04	1.54E-03	[4]	1.08E-02	0.035	0.047
VOC	2.52E-04	1.84E-03	[8]	1.29E-02	0.04	0.06
GHG-Mass		--	[9]	1,141.43	3,749.61	4,999.48
CO_2	--	1.63E+02	[6]	1,141	3,749.42	4,999.23
CH_4	--	6.61E-03	[6]	4.63E-02	0.15	0.20
N_2O	--	1.32E-03	[6]	9.26E-03	0.03	0.04
GHG-CO2e	--	--	[9]	1,145	3,413.09	4,550.79
CO_2	--	--	[10]	1,141	3,401.42	4,535.23
CH_4	--	--	[10]	1.16	3.45	4.60
N_2O	--	--	[10]	2.76	8.22	10.96

Notes [ ]:
1. Based on preliminary vendor data.
2. Based on fuel characteristics listed in Reference 2.
3. Total particulate matter is the sum of filterable and condensable PM, given in AP-42 (Reference 1b).
4. Assumed all sulfur in the fuel is converted to SO_2.
5. Criteria pollutant emission factors obtained from AP-42 (Reference 1a) for boilers < 100 Million Btu/hr.
6. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.
7. Particle size distribution obtained from AP-42 (Reference 1c).
8. AP-42 includes VOCs within Total Organic Compounds (TOCs), which also includes semi-volatile organic compounds and condensable organic compounds (Reference 1d).
9. The GHG emissions is the sum of all applicable GHG pollutants.
10. CO_2 equivalents (CO_2e) based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials in metric tons.
11. Emissions for Year 6 are based on operations beginning in April (9 months of the year).
12. Emissions for tons in Years 7 and 8 are based on operations for a full annual period.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Chapter 1 "External Combustion Sources", Section 1.3 "Fuel Oil Combustion". September 1999.
    a. Table 1.3-1 "Criteria Pollutant Emission Factors for Fuel Oil Combustion".
    b. Table 1.3-2 "Condensable Particulate Matter Emission Factors for Oil Combustion"
    c. Table 1.3-6 "Cumulative Particle Size Distribution and Size-Specific Emission Factors for Uncontrolled Industrial Boilers Firing Distillate Oil."
    d. Table 1.3-3 "Emission Factors for Total Organic Compounds (TOC), Methane, and Nonmethane TOC (NMTOC) From Uncontrolled Fuel Oil Combustion."
2. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

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Fort Drum (FTD) Training Range Site 7

Baseline Schedule

Calculate Annual Fuel Usage for Fuel Storage Tanks During Operations

Fuel Tank Diameter [(1)] (ft)	Fuel Tank Length [(1)] (ft)	Type of Fuel Tank [(2)]	Fuel Tank Capacity [(2)] (gal)	Number of Tanks [(2)]	Number of RICE Engines	Hours Per Year of RICE Engines [(3)]	Fuel Consumption Rate [(4)] (gal/hr)	Annual Fuel Consumption (gal/yr)	Annual Tank Turnovers
5.42	9	Vertical	1,500	4	4	500	210.7	421,400	280.93
10	51	Horizontal	30,000	3	4	500	210.7	421,400	14.05

Notes [ ]:

1. The fuel tank diameter and length were estimated using the National Board Standards from Engineering Toolbox Website (http://www.engineeringtoolbox.com/fuel-oil-storage-tanks-dimensions-d_1585.html). These numbers are used as input into the USAF's ACAM model to estimate VOC emissions from the fuel storage tanks.
2. The potential fuel storage tank parameters (i.e., type, number, and capacity) are based on information contained in the potential CIS deployment's Section 2.3 of the EIS.
3. The emission anlayis for the backup RICE engines assumes that the engines will operate 400 hours or less per year.
4. Fuel consumption rates are based on the manufacturer's specifications for a Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum operating at maximum load.

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Fort Drum (FTD) Training Range Site 7

Baseline Schedule

Air Emissions Estimate for Fuel Storage Tanks During Operations

Emission Activitiy	Estimated Annual Air Emissions (tons/year) [1]													
	Year 6							Year 7						
	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Fuel Storage Tanks	0.048	0	0	0	0	0	0	0.064	0	0	0	0	0	0

Notes [ ]:

1. The fuel storage tanks will emit VOC's during operations. The amount of VOC's emitted was estimated using the USAF's ACAM model (Version 5.02) using as input the dimensions of the tank and the amount of turnovers per year for each tank.

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Fort Drum (FTD) Training Range Site 7

Baseline Schedule

Air Emissions Estimate for Worker Vehicles During Operations

Vehicle Type (1)	Trips/ Day (2)	Days/Year (3)		Miles/ Trip (4)	Emission Factor (g/mi) (5)							Estimated Annual Air Emissions (tons/year) (6) Year 6							Year 7						
		Year 6	Year 7		VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Passenger Car	425	275	365	50	0.265	2.954	0.008	0.007	0.193	324.97	0.002	1.71	19.03	0.05	0.05	1.24	1,899	0.013	2.27	25.26	0.07	0.06	1.65	2,521	0.017
Light Duty Truck	425	275	365	50	0.311	3.906	0.011	0.011	0.333	419.21	0.003	2.00	25.16	0.07	0.07	2.15	2,450	0.019	2.66	33.40	0.09	0.09	2.85	3251.51	0.026
											Total Annual Emission	3.71	44.19	0.12	0.12	3.39	4,349	0.032	4.92	58.65	0.16	0.15	4.50	5,772	0.043

Notes [ ]:

1. It is assumed that the fleet of worker vehicles will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
2. Trips per day is based on the maximum number of workers during operation of the potential CIS deployment as listed in the Section 2.3 of the EIS.
   A maximum of 850 workers are expected daily which is split between the two vehicle types. The workers include military,
   civilian, and contractor support maintenance personnel.
3. Days per year assumes that the potential CIS deployment will require workers traveling to the site each day of the year. It is assumed that operations will start during April of Year 6.
4. Total miles/trip is a roundtrip distance traveled by the worker vehicles to account for indirect emissions during operation of the potential CIS deployment.
5. The emission factors are from the United States Air Force (USAF) Air Conformity Applicability Model (ACAM).
   The ACAM model emission factors are derived from the United States Environmental Protection Agency (USEPA)
   Motor Vehicle Emission Simulator (MOVES) computer model. Emission Factors are for 2020 and are used for Years 6 and 7 (Years 2021 and 2022, respectively).
6. The total annual emissions for CO_2 emission is in units of metric tons per year. The total annual emissions
   for VOC, CO, PM_{10}, $PM_{2.5}$, NO_x, and SO_2 is provided in units of tons per year.

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Fort Drum (FTD) Training Range Site 7

Baseline Schedule

Summary of Air Emissions Estimate During Operation of the Potential CIS Deployment

Pollutant	Estimated Annual Emissions (ton/year) [1]	
	Year 6	Year 7
NO_X	38.5	51.3
VOC	35.5	47.4
SO_2	0.10	0.13
$PM_{2.5}$	1.2	1.6
PM_{10}	1.4	1.9
CO	62.4	82.9
GHG - CO_{2e} Basis	10,975	14,607

Notes [ ]:

1. The air emissions of carbon dioxide equivalents (CO_2e) are provided in metric tons per year.
   The air emissions of criteria pollutants are provided in tons per year.

Operation – Expedited Schedule

FTD Training Range Site 7

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FTD Training Range Site 7

Expedited Schedule

Air Emissions Estimate for Power Plant Generators

Basis:

Number of Units	4	
Fuel	Diesel Fuel Oil	
Power Rating	3,000	kW
Heat Input	28.87	mmBtu/hr
Heating Value of Fuel	137,000	Btu/gal [2]
Fuel Burn Rate	211	gal/hr [1]
Hours of Operation	500	hours per year
Density of Fuel	7.05	lb/gal [2]
Sulfur Content of Fuel	0.0015	% [3]

Global Warming Potentials [4]

CO_2	1
CH_4	25
N_2O	298

Pollutant	Mass Emission Rate				Annual Emissions (tpy)	
	g/kw-hr	lb/mmBtu	Notes	lb/hr	Year 4	Year 5
CO	3.50		[8]	23.15	5.79	23.15
NO_X	6.40		[8]	42.33	10.58	42.33
PM	0.20		[8]	1.32	0.33	1.32
PM_{10}	0.20		[5]	1.32	0.33	1.32
$PM_{2.5}$	0.20		[5]	1.32	0.33	1.32
SO_2	0.0067		[6]	0.045	0.01	0.04
VOC	6.40		[8,9]	42.33	10.58	42.33
GHG-Mass	--	--	[8]	4,707	1,177	4,707
CO_2	--	1.63E+02	[10]	4,706.70	1,177	4,707
CH_4	--	6.61E-03	[10]	0.19	0.05	0.19
N_2O	--	1.32E-03	[10]	3.82E-02	0.01	0.04
GHG-CO2e	--		[7]	4,723	1,071	4,284
CO_2	--		[4]	4,707	1,067	4,270
CH_4	--		[4]	4.77	1.08	4.33
N_2O	--		[4]	11.4	2.58	10.32

Notes [ ]:

1. Based on manufacturer's specifications for Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum power rating.
2. Based on diesel fuel characteristics listed in Reference 1.
3. Based on the requirements of 40 CFR Part 63, Subpart ZZZZ and 40 CFR Part 80.510(b).
4. CO_2 equivalents (CO_2e) provided in metric tons based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
5. It is assumed that the PM_{10} and $PM_{2.5}$ emission factors are the same as PM.
6. Assumed all sulfur in the fuel is converted to SO_2.
7. The GHG emissions is the sum of all applicable GHG pollutants.
8. Emission limits for Tier II engine manufactured after 2010 and >900 kW - 40 CFR §89.112(a), Table 1.
9. Emission limit provided by Tier II standards is for NO_X+NMHC. Engine VOC emissions were conservatively assumed to be equal to the entire emission limit of 6.4 g/kW-hr.
10. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

FTD Training Range Site 7

Expedited Schedule

Air Emissions Estimate for 7 MMBtu/hr Boilers

Basis:

Number of Boilers	1	
Fuel	Diesel Fuel Oil	

Boiler Information

Heat Input	7.0	MMBtu/hr [1]
Heating Value of Fuel	137,000	Btu/gal[2]
Fuel Burn Rate	51	gal/hr
Hours of Operation (Per Boiler)	8,760	hours per year
Annual Fuel Usage (Cumulative)	447,591	gal/year
Sulfur Content of Fuel	0.0015	%

Miscellaneous Data

Density of Fuel Oil	7.05	lb/gal[2]
SO_2 to SO_3 Conversion Rate	100	% by volume (assumed)
Molecular Weight of Sulfur	32	lb/lb-mol
Molecular Weight of Oxygen	16	lb/lb-mol
Molecular Weight of Hydrogen	1	lb/lb-mol

Global Warming Potentials [10]	
CO_2	1
CH_4	25
N_2O	298

Boiler Emissions Summary

Pollutant	Mass Emission Rate (per unit)				Annual Emissions (tpy)	
	(lb/gal)	(lb/MMBtu)	Notes	(lb/hr)	Year 4 [11]	Year 5 [12]
CO	0.005	0.036	[5]	0.26	0.28	1.12
NO_X	0.02	0.146	[5]	1.02	1.12	4.48
PM (total)	0.0033	0.0241	[2,3,5]	0.169	0.18	0.74
PM (filterable)	0.0020	0.0146	[2,3,5]	0.102	0.11	0.45
PM (condensable)	0.0013	0.0095	[2,3]	0.066	0.07	0.29
PM_{10}		0.012	[7]	0.08	0.09	0.37
$PM_{2.5}$		0.003	[7]	0.020	0.02	0.09
SO_2	2.12E-04	1.54E-03	[4]	1.08E-02	0.01	0.05
VOC	2.52E-04	1.84E-03	[8]	1.29E-02	0.01	0.06
GHG-Mass		--	[9]	1,141.43	1,249.87	4,999.48
CO_2	--	1.63E+02	[6]	1,141	1,249.81	4,999.23
CH_4	--	6.61E-03	[6]	4.63E-02	0.05	0.20
N_2O	--	1.32E-03	[6]	9.26E-03	0.01	0.04
GHG-CO2e	--	--	[9]	1,145	1,137.70	4,550.79
CO_2	--	--	[10]	1,141	1,133.81	4,535.23
CH_4	--	--	[10]	1.16	1.15	4.60
N_2O	--	--	[10]	2.76	2.74	10.96

Notes [ ]:

1. Based on preliminary vendor data.
2. Based on fuel characteristics listed in Reference 2.
3. Total particulate matter is the sum of filterable and condensable PM, given in AP-42 (Reference 1b).
4. Assumed all sulfur in the fuel is converted to SO_2.
5. Criteria pollutant emission factors obtained from AP-42 (Reference 1a) for boilers < 100 Million Btu/hr.
6. Emission factors obtained from 40 CFR Part 98, Tables C-1 & C-2.
7. Particle size distribution obtained from AP-42 (Reference 1c).
8. AP-42 includes VOCs within Total Organic Compounds (TOCs), which also includes semi-volatile organic compounds and condensable organic compounds (Reference 1d).
9. The GHG emissions is the sum of all applicable GHG pollutants.
10. CO_2 equivalents (CO_2e) based on the global warming potential for applicable pollutant as listed in Table A-1 to Subpart A of 40 CFR Part 98 - Global Warming Potentials.
11. Emissions for Year 4 are based on operations beginning in October (3 months of the year).
12. Emissions for tons in Year 5 are based on operations for a full annual period.

References:

1. USEPA, AP-42, Fifth Edition, Vol. I. Chapter 1 "External Combustion Sources", Section 1.3 "Fuel Oil Combustion". September 1999.
   a. Table 1.3-1 "Criteria Pollutant Emission Factors for Fuel Oil Combustion".
   b. Table 1.3-2 "Condensable Particulate Matter Emission Factors for Oil Combustion"
   c. Table 1.3-6 "Cumulative Particle Size Distribution and Size-Specific Emission Factors for Uncontrolled Industrial Boilers Firing Distillate Oil."
   d. Table 1.3-3 "Emission Factors for Total Organic Compounds (TOC), Methane, and Nonmethane TOC (NMTOC) From Uncontrolled Fuel Oil Combustion."
2. USEPA, AP-42, Fifth Edition, Vol. I. Appendix A "Miscellaneous Data & Conversion Factors". September 1985.

CONUS CIS

FTD Training Range Site 7

Expedited Schedule

Calculate Annual Fuel Usage for Fuel Storage Tanks During Operations

Fuel Tank Diameter [(1)] (ft)	Fuel Tank Length [(1)] (ft)	Type of Fuel Tank [(2)]	Fuel Tank Capacity [(2)] (gal)	Number of Tanks [(2)]	Number of RICE Engines	Hours Per Year of RICE Engines [(3)]	Fuel Consumption Rate [(4)] (gal/hr)	Annual Fuel Consumption (gal/yr)	Annual Tank Turnovers
5.42	9	Vertical	1,500	4	4	500	210.7	421,400	280.93
10	51	Horizontal	30,000	3	4	500	210.7	421,400	14.05

Notes [ ]:

1. The fuel tank diameter and length were estimated using the National Board Standards from Engineering Toolbox Website (http://www.engineeringtoolbox.com/fuel-oil-storage-tanks-dimensions-d_1585.html). These numbers are used as input into the USAF's ACAM model to estimate VOC emissions from the fuel storage tanks.
2. The potential fuel storage tank parameters (i.e., type, number, and capacity) are based on information contained in the potential CIS deployment's Chapter 2.3 of the EIS.
3. The emission analysis for the backup RICE engines assumes that the engines will operate 500 hours or less per year.
4. Fuel consumption rates are based on the manufacturer's specifications for a Caterpillar C175-16 Engine Generator Set - 3100 ekW maximum operating at maximum load.

CONUS CIS

FTD Training Range Site 7

Expedited Schedule

Air Emissions Estimate for Fuel Storage Tanks During Operations

Emission Activity	Estimated Annual Air Emissions (tons/year) [1]													
	Year 4							Year 5						
	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Fuel Storage Tanks	0.016	0	0	0	0	0	0	0.064	0	0	0	0	0	0

Notes [ ]:

1. The fuel storage tanks will emit VOC's during operations. The amount of VOC's emitted was estimated using the USAF's ACAM model (Version 5.02) using as input the dimensions of the tank and the amount of turnovers per year for each tank.

CONUS CIS

FTD Training Range Site 7

Expedited Schedule

Air Emissions Estimate for Worker Vehicles During Operations

Vehicle Type (1)	Trips/ Day (2)	Days/Year (3)		Miles/ Trip (4)	Emission Factor (g/mi) (5)							Estimated Annual Air Emissions (tons/year) (6)													
												Year 4							Year 5						
		Year 4	Year 5		VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$	NO_x	CO_2	SO_2
Passenger Car	425	92	365	50	0.291	3.115	0.009	0.008	0.223	334.45	0.002	0.63	6.71	0.02	0.02	0.48	654	0.004	2.49	26.63	0.08	0.07	1.91	2,594	0.017
Light Duty Truck	425	92	365	50	0.342	4.192	0.012	0.010	0.382	431.48	0.003	0.74	9.03	0.03	0.02	0.82	844	0.006	2.92	35.84	0.10	0.09	3.27	3346.65	0.026
											Total Annual Emission	1.36	15.75	0.05	0.04	1.30	1,497	0.011	5.41	62.47	0.18	0.15	5.17	5,941	0.043

Notes [ ]:

1. It is assumed that the fleet of worker vehicles will be a mix of 50 percent passenger cars and 50 percent light-duty gasoline trucks.
2. Trips per day is based on the maximum number of workers during operation of the potential CIS deployment as listed in Chapter 2 of the EIS. A maximum of 850 workers are expected daily which is split between the two vehicle types. The workers include military, civilian, and contractor support maintenance personnel.
3. Days per year assumes that the potential CIS deployment will require workers traveling to the site each day of the year. It is assumed that operations will start during October of Year 4.
4. Total miles/trip is a roundtrip distance traveled by the worker vehicles to account for indirect emissions during operation of the potential CIS deployment.
5. The emission factors are from the United States Air Force (USAF) Air Conformity Applicability Model (ACAM). The ACAM model emission factors are derived from the United States Environmental Protection Agency (USEPA) Motor Vehicle Emission Simulator (MOVES) computer model. Emission Factors are for 2019 and are used for Years 4 and 5.
6. The total annual emissions for CO_2 emission is in units of metric tons per year. The total annual emissions for VOC, CO, PM_{10}, $PM_{2.5}$, NO_x, and SO_2 is provided in units of tons per year.

CONUS CIS

FTD Training Range Site 7

Expedited Schedule

Summary of Air Emissions Estimate During Operation of the Potential CIS Deployment

Pollutant	Estimated Annual Emissions (ton/year) [1]	
	Year 4	Year 5
NO_X	13.0	52.0
VOC	12.0	47.9
SO_2	0.03	0.13
$PM_{2.5}$	0.4	1.6
PM_{10}	0.5	1.9
CO	21.8	86.7
GHG - CO_{2e} Basis	3,706	14,776

Notes [ ]:

1. The air emissions of carbon dioxide equivalents (CO_2e) are provided in metric tons per year. The air emissions of criteria pollutants are provided in tons per year.

APPENDIX E

CULTURAL RESOURCES SUPPORTING INFORMATION

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Appendix E.1

FCTC Sites - Cultural Resources – Documentation

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STATE OF MICHIGAN
DEPARTMENT OF MILITARY & VETERANS AFFAIRS
LANSING

RICK SNYDER
GOVERNOR

MG GREGORY J. VADNAIS
THE ADJUTANT GENERAL AND DIRECTOR

November 20, 2015

Mr Brian D. Conway
State Historic Preservation Officer
Michigan State Housing Development Authority
702 W. Kalamazoo Street
Lansing, MI 48909-8240

Dear Mr. Conway:

The Michigan Department of Military and Veterans Affairs is cooperating with the US Missile Defense Agency (MDA) in evaluating the environmental impacts from the potential construction of a Continental United States Interceptor Site (CIS) at two potential sites at the Fort Custer Training Center (FCTC). FCTC is one of four facilities being considered for potential construction of a CIS in an Environmental Impact Statement (EIS). We have conducted the background research, consultation, archaeological and architectural surveys pursuant to Section 800.4(a) and (b) of the regulations in order to identify properties that may be affected by this potential project. Most recently a Targeted Phase I survey was conducted in this project footprint area to resolve several archaeological issues (Orbis, Final Report August 26, 2015, attached).

As a result of our efforts to identify and evaluate historic properties, we have determined, pursuant to 36 CFR §800.4(d)(1), that there are **no significant adverse effects to historic properties** as a result of this potential project.

We base our determination on the following:

1. Predictive models have been created and tested and Phase I & II surveys conducted at the post except for the north impact area (risk of unexploded ordinance). Please see the enclosed project location site maps, maps of all known archaeological sites in the project areas, this year's Orbis final report, and the Sec. 106 Review Application.

2. The APE includes two main geographic areas south of Territorial Road (Sites 1 and 2 on the "Previous Cultural Resource Investigations" map). The northern "Keep Out Area" of Site 2 is near Territorial Road but will not be cleared of tall vegetation, so the viewshed from Territorial Road (the only property at FCTC eligible to the NRHP) should not be impacted. In the unlikely event that it is, a simple mitigation would be to plant evergreen trees outside the Keep Out Area to block visibility from the road. Site 1 would impact 8 to 9 non-eligible farmstead archaeological sites and Site 2 would impact 5 to 6 non-eligible farmstead archaeological sites.

If we do not hear from your office within thirty (30) days as per 36 CFR 800.4(d)(1)(i), we will assume that you concur with this determination and will proceed with the project. If you have any questions about this project, please contact Nathan Krupp, Cultural Resources Program Manager, at 517-481-7635.

Sincerely,

Nathan Krupp

Nathan Krupp
Cultural Resource Manager
MI Dept. of Military & Veterans Affairs

blc:nck
enclosures

Environmental Division
3423 N. Martin Luther King Jr. Blvd.
Lansing, MI 48906-2934

STATE HISTORIC PRESERVATION OFFICE
Application for Section 106 Review

SHPO Use Only					
☐	IN	Received Date	___ / ___ / ___	Log In Date	___ / ___ / ___
☐	OUT	Response Date	___ / ___ / ___	Log Out Date	___ / ___ / ___
		Sent Date	___ / ___ / ___		

Submit one copy for each project for which review is requested. This application is required. Please *type.* *Applications must be complete for review to begin. Incomplete applications will be sent back to the applicant without comment. Send only the information and attachments requested on this application. Materials submitted for review cannot be returned. Due to limited resources we are unable to accept this application electronically.*

I. GENERAL INFORMATION

☒ THIS IS A NEW SUBMITTAL ☐ THIS IS MORE INFORMATION RELATING TO ER#

a. Project Name: Fort Custer Potential CIS Construction
b. Project Address (if available): Fort Custer Training Center, 2501 26th St., Augusta, MI 49012
c. Municipal Unit: Augusta County: Kalamazoo and Calhoun
d. Federal Agency, Contact Name and Mailing Address (*If you do not know the federal agency involved in your project please contact the party requiring you to apply for Section 106 review, not the SHPO, for this information.*): Army National Guard, Army Corps of Engineers, DoD, Missile Defense Agency
e. State Agency (if applicable), Contact Name and Mailing Address: Military & Veterans Affairs, Nathan Krupp
f. Consultant or Applicant Contact Information (if applicable) *including mailing address*: Reserve Forces Support Center, Environmental Division, Nathan Krupp, 3423 N. MLK Jr. Blvd, Lansing, MI 48906, 517-481-7635

II. GROUND DISTURBING ACTIVITY (INCLUDING EXCAVATION, GRADING, TREE REMOVALS, UTILITY INSTALLATION, ETC.)

DOES THIS PROJECT INVOLVE GROUND-DISTURBING ACTIVITY? ☒ YES ☐ NO (If no, proceed to section III.)

Exact project location must be submitted on a USGS Quad map (portions, photocopies of portions, and electronic USGS maps are acceptable as long as the location is clearly marked).

a. USGS Quad Map Name: Augusta
b. Township: 02S Range: 8&9W Section: 13-24
c. Description of width, length and depth of proposed ground disturbing activity: The Missile Defense Agency (MDA) has selected the Fort Custer Training Center (FC) as one of 4 potential sites to build a potential Continental United States Interceptor Site (CIS). This DoD agency has, in turn, selected two potential sites at FC, each containing a maximum of 60, 80' deep interceptor silos. Site clearing, leveling, building foundations and trenching for utilities would disturb approximately 805 acres at Site 1 and approximately 831 acres at Site 2 (see enclosed maps). The outer 'Keep Out Areas' would require signage but would not be cleared of vegetation.
d. Previous land use and disturbances: 19th Century timber removal and agriculture, military vehicle maneuver area from ~1917 to present, and previous military timber cutting operations.
e. Current land use and conditions: Federally owned military training area. The area is mostly forested with oak, black cherry and maple dominating with small patches of grasslands.
f. Does the landowner know of any archaeological resources found on the property? ☒ YES ☐ NO

Please describe: In preparation for this potential project, a Targeted Phase I archaeological survey was conducted on several sites S of Territorial Road (Orbis, 2015, enclosed). Using a predictive model and maps/atlasses, the entire post was surveyed for archaeological resources in 2004 by Commonwealth Cultural Resources Group (Final Report, July 2006). A reconnaissance level survey by the Corps of Engineers and several site-specific surveys preceded it. Farmstead archaeological sites showing promise received Phase II survey in 2005 (final report 2008), also by CCRG, and all were declared ineligible (SHPO concurrence letter dated February 25, 2008). The Territorial Road segment on Fort Custer, an Eligible, linear, vernacular historic landscape, runs E-W through the middle of the post. On all of FC a total of 67 sites are currently reported but two are likely duplicates. Site 1 contains 8-9 noneligible farmstead archaeological sites and Site 2, 5-6 noneligible archaeological sites within their respective APEs.

III. PROJECT WORK DESCRIPTION AND AREA OF POTENTIAL EFFECTS (APE)
Note: Every project has an APE.

a. Provide a detailed written description of the project (plans, specifications, Environmental Impact Statements (EIS), Environmental Assessments (EA), etc. **cannot** be substituted for the written description): This potential project would construct and operate a Continental United States Interceptor Site (CIS) to defend against a ballistic missile attack. The CIS would consist of 5 roads, utilities and communication connecting a power plant, sewage treatment plant and at least 21 other buildings and facilities, up to 60 underground silos covering approximately 805 to 831 acres. A decision by DoD to deploy has not been made.

   b. Provide a localized map indicating the location of the project; road names must be included and legible.
   c. On the above-mentioned map, identify the APE.
   d. Provide a written description of the APE (physical, visual, auditory, and sociocultural), the steps taken to identify the APE, and the justification for the boundaries chosen. The APE includes the area inside the outermost perimeter of Site 1 or Site 2 on the "Previous Cultural Resource Investigations" map. Two locations along the north 'Keep Out Area' fenceline of Site 2 come close to and may impact the viewshed from Territorial Road. If this site is chosen evergreen trees may need to be planted as a visual screen.

IV. IDENTIFICATION OF HISTORIC PROPERTIES

a. List and date **all** properties 50 years of age or older located in the APE. If the property is located within a National Register eligible, listed or local district it is only necessary to identify the district: There are 8-9 non-eligible archaeological farmsteads in Site 1 and 5-6 within Site 2. Site 2 might impact the viewshed from Territorial Road, a contributing feature to this eligible rural, vernacular, linear historic landscape.
b. Describe the steps taken to identify whether or not any **historic** properties exist in the APE and include the level of effort made to carry out such steps: The entire post has been surveyed for archaeological properties utilizing a tested predictive model, Phase I survey and Phase II surveys conducted on the more promising sites (see II.f.). No archaeological sites on Fort Custer have been found eligible to the National Register of Historic Places. The Fort Custer segment of Territorial Road has been deemed eligible to the National Register of Historic Places as a linear, rural, vernacular historic landscape and its viewshed may be inside this project's APE at the north end of Site 2.
c. Based on the information contained in "b", please choose one:
   - ☒ Historic Properties Present in the APE
   - ☐ No Historic Properties Present in the APE
d. Describe the condition, previous disturbance to, and history of any historic properties located in the APE: Territorial Road was once paved (asphalt) from Augusta Climax Road west to and beyond 40th Street (historic and current western post boundary), the homesteads/farmsteads along the road razed, the road graded, brush cut back, culverts replaced and ditches reestablished many times since the historic period (1830 when road construction began to 1917, when the War Dept. first leased then purchased the original parcels to create Camp Custer).

V. PHOTOGRAPHS

Note: All photographs must be keyed to a localized map.

a. Provide photographs of the site itself.
b. Provide photographs of all properties 50 years of age or older located in the APE (faxed or photocopied photographs are not acceptable).

VI. DETERMINATION OF EFFECT

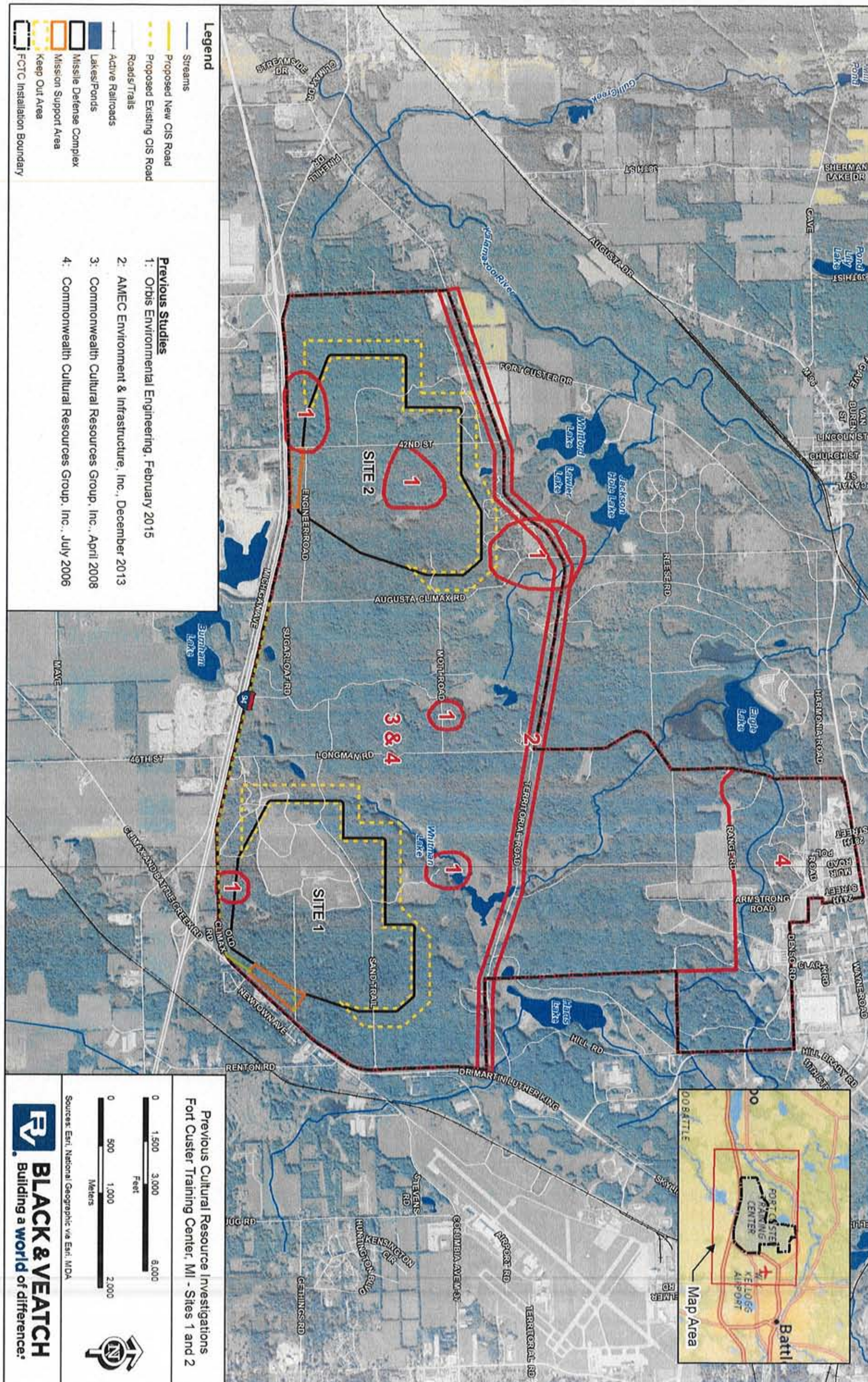
☐ No historic properties affected based on [36 CFR § 800.4(d)(1)], please provide the basis for this determination.

☒ No Adverse Effect [36 CFR § 800.5(b)] on historic properties, explain why the criteria of adverse effect, 36 CFR Part 800.5(a)(1), were found not applicable.

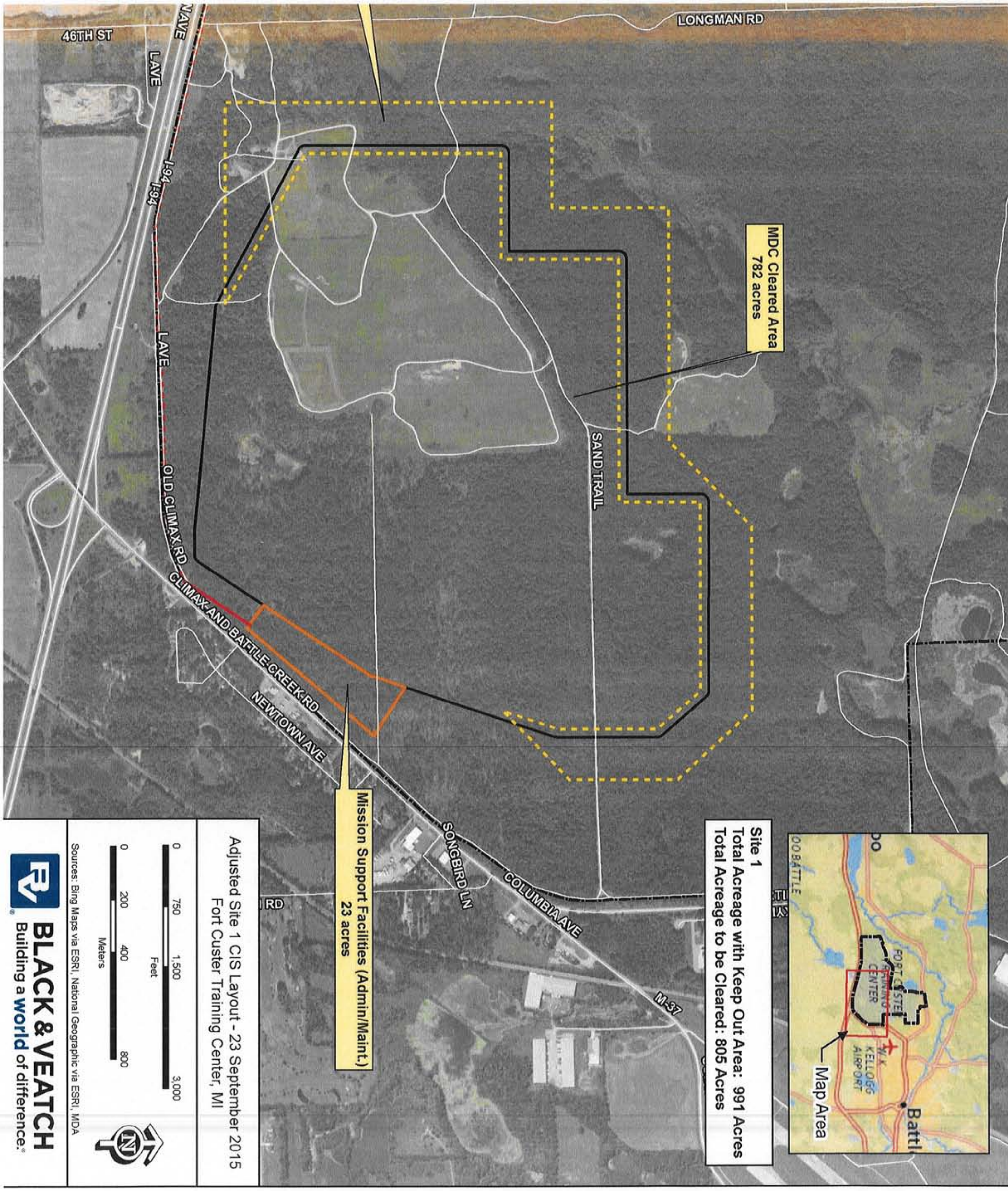
☐ Adverse Effect [36 CFR § 800.5(d)(2)] on historic properties, explain why the criteria of adverse effect, [36 CFR Part 800.5(a)(1)], were found applicable.

Please print and mail completed form and required information to:

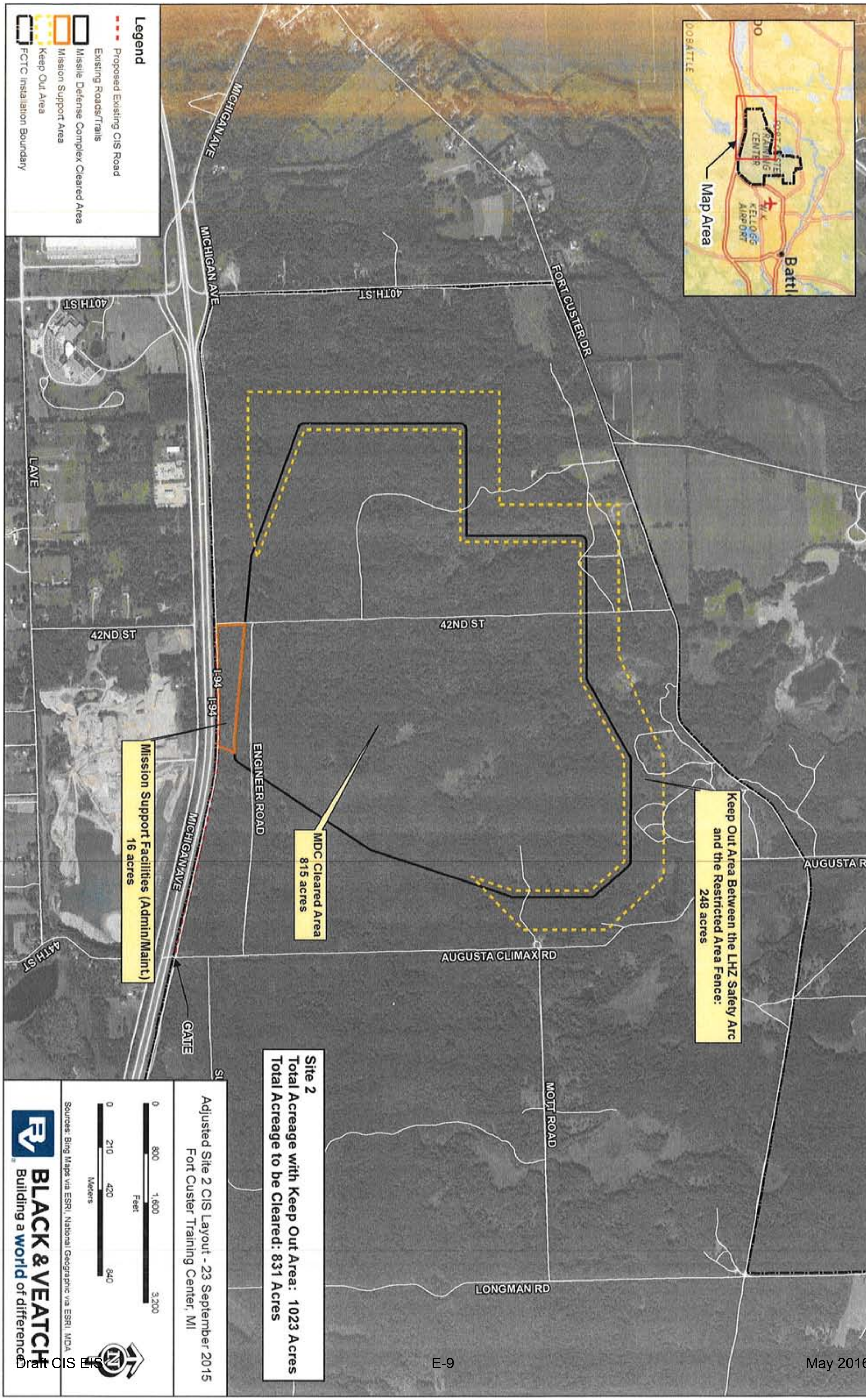
State Historic Preservation Office, Environmental Review Office, Michigan Historical Center, 702 W. Kalamazoo Street, P.O. Box 30740, Lansing, MI 48909-8240



Legend
Streams
Proposed New CIS Road
Proposed Existing CIS Road
Roads/Trails
Active Railroads
Lakes/Ponds
Missile Defense Complex
Mission Support Area
Keep Out Area
FCTC Installation Boundary
Previous Studies
1: Orbis Environmental Engineering, February 2015
2: AMEC Environment & Infrastructure, Inc., December 2013
3: Commonwealth Cultural Resources Group, Inc., April 2008
4: Commonwealth Cultural Resources Group, Inc., July 2006
SITE 1
SITE 2
3 & 4
Map Area
FORT CUSTER TRAINING CENTER
KELLOGG AIRPORT
Previous Cultural Resource Investigations
Fort Custer Training Center, MI - Sites 1 and 2
0 1,500 3,000 6,000
Feet
0 500 1,000 2,000
Meters
Sources: Esri, National Geographic via Esri, MDA
BLACK & VEATCH
Building a world of difference.



46TH ST
LONGMAN RD
N AVE
L AVE
I-94
I-94
L AVE
OLD CLIMAX RD
CLIMAX AND BATTLE CREEK RD
NEWTOWN AVE
SAND TRAIL
SONGBIRD LN
COLUMBIA AVE
M-37
MDC Cleared Area
782 acres
Mission Support Facilities (Admin/Maint.)
23 acres
Site 1
Total Acreage with Keep Out Area: 991 Acres
Total Acreage to be Cleared: 805 Acres
Map Area
Adjusted Site 1 CIS Layout - 23 September 2015
Fort Custer Training Center, MI
0 750 1,500 3,000
Feet
0 200 400 800
Meters
Sources: Bing Maps via ESRI, National Geographic via ESRI, MDA
BLACK & VEATCH
Building a world of difference.



Legend
Proposed Existing CIS Road
Existing Roads/Trails
Missile Defense Complex Cleared Area
Mission Support Area
Keep Out Area
FCTC Installation Boundary
Map Area
Battle
KELLOGG AIRPORT
MICHIGAN AVE
40TH ST
FORT CUSTER DR
42ND ST
I-94
ENGINEER ROAD
AUGUSTA RD
AUGUSTA CLIMAX RD
44TH ST
L AVE
GATE
MOTT ROAD
LONGMAN RD
Mission Support Facilities (Admin/Maint.)
16 acres
MDC Cleared Area
815 acres
Keep Out Area Between the LHZ Safety Arc and the Restricted Area Fence:
248 acres
Site 2
Total Acreage with Keep Out Area: 1023 Acres
Total Acreage to be Cleared: 831 Acres
Adjusted Site 2 CIS Layout - 23 September 2015
Fort Custer Training Center, MI
0 800 1,600 3,200
Feet
0 210 420 840
Meters
Sources: Bing Maps via ESRI, National Geographic via ESRI, MDA
BLACK & VEATCH
Building a world of difference

Source: Delorme 2003 U.S.G.S. 7.5' Augusta (1961, Photorevised 1985) and Galesburg (1961, Photorevised 1985) Quadrangles, Michigan

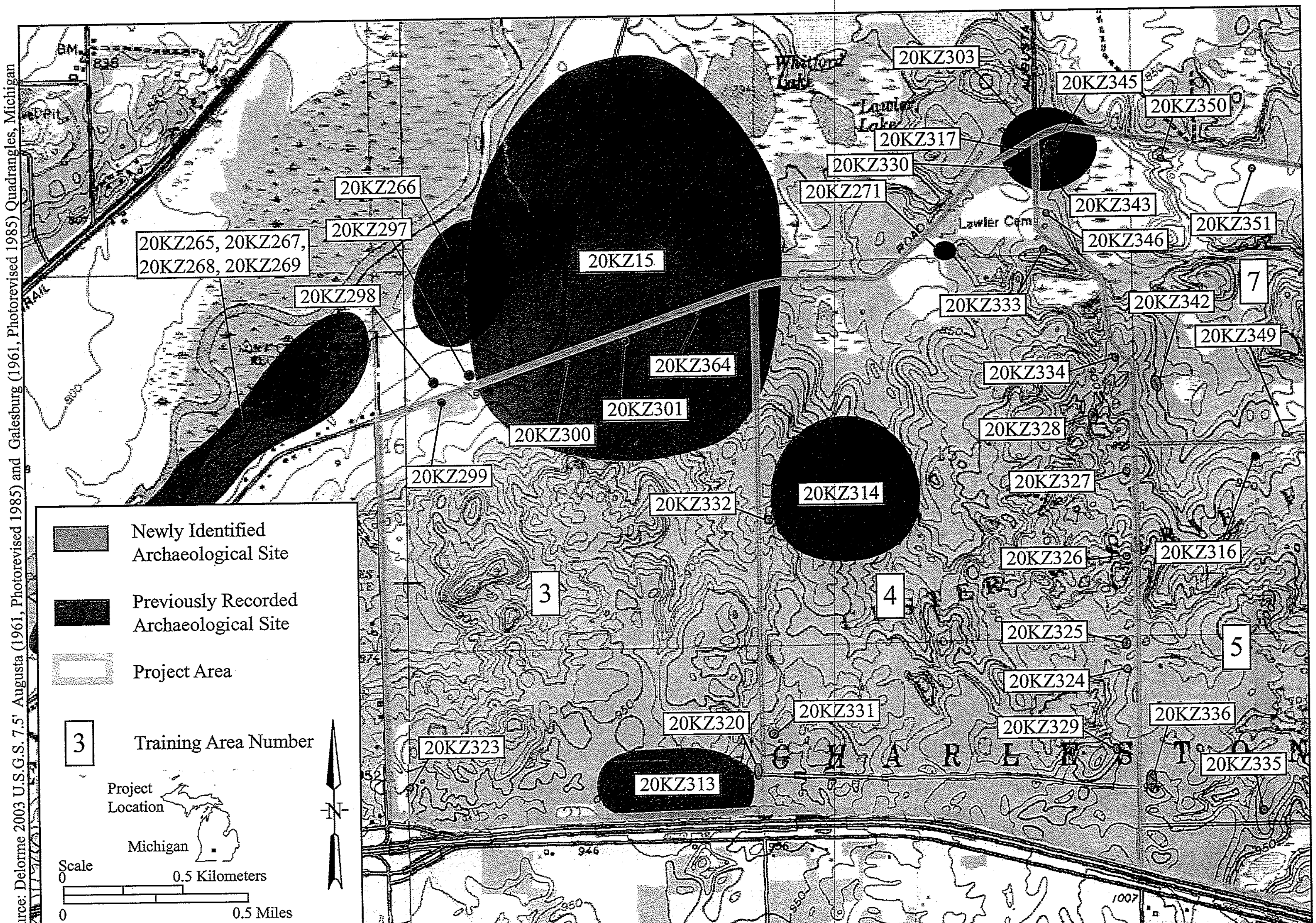


Figure 1.0-1a. Project Location, Newly Identified Archaeological Sites, and Nearby Archaeological Sites

From: "Phase I Archaeological Survey, Fort Custer Army National Guard Training Center, Kalamazoo and Calhoun Counties, Michigan," CCRG, July 2006. 313; prob = 320

Source: Delorme 2003 U.S.G.S. 7.5' Augusta (1961, Photorevised 1985) Quadrangle, Michigan

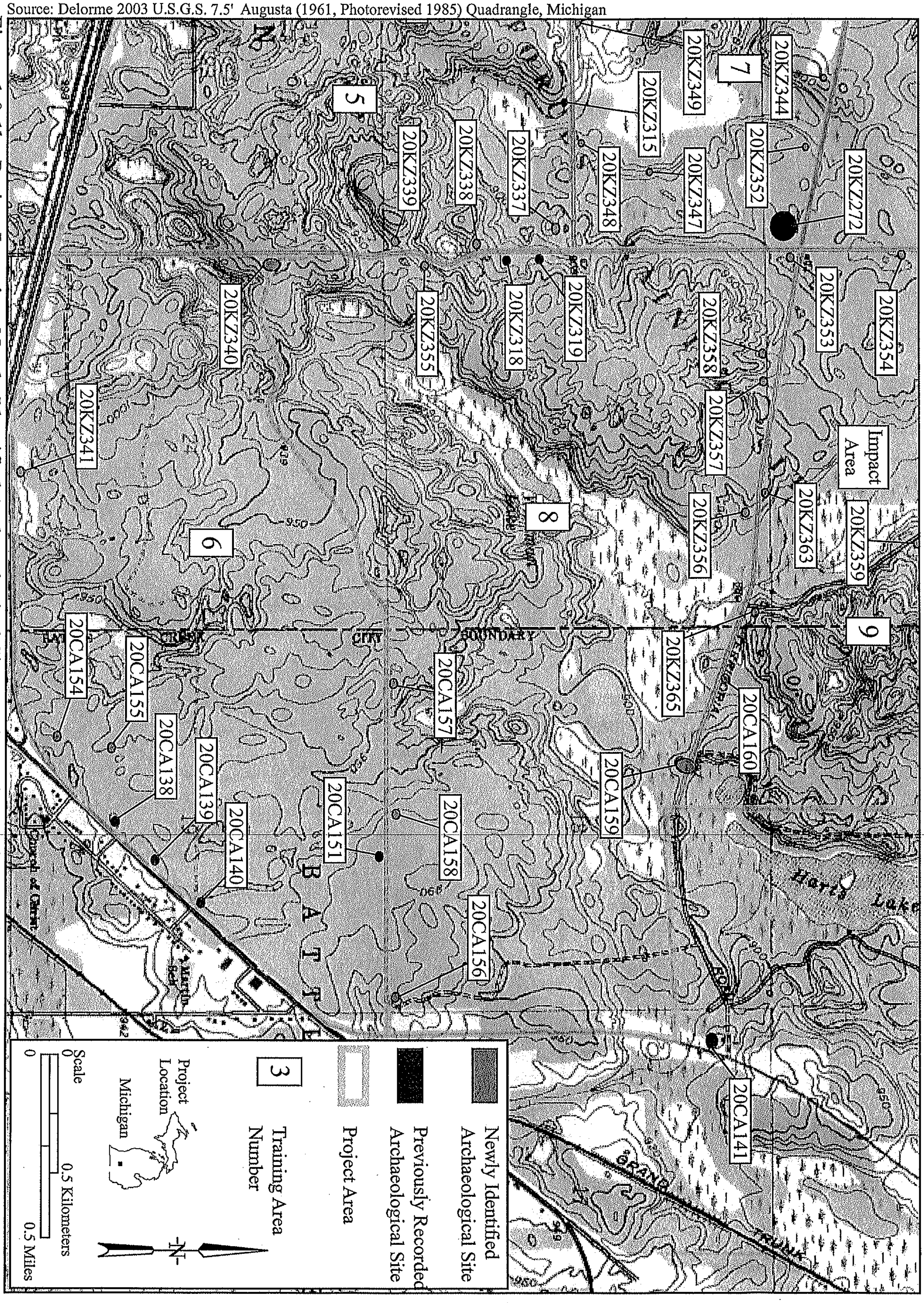


Figure 1.0-1b. Project Location, Newly Identified Archaeological Sites, and Nearby Archaeological Sites

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Appendix E.2

CRJMTC - Cultural Resources – Documentation

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OHIO HISTORY

December 14, 2006

Kimberly S. Ludt
The Adjutant General's Department
Ravenna Training and Logistics Site
Environmental Office
1438 State Route 534 SW
Newton Falls, Ohio 44444

Dear Ms. Ludt:

This is in response to your letter of November 6, 2006 transmitting "Phase I Archaeological Reconnaissance Survey for a Proposed Engineering School and Ranges at the Ravenna Training and Logistics Site, Windham and Paris Townships, Portage County, Ohio" by Ryan J. Peterson, Susan Andrews, and Melinda Wetzel. Our comments are submitted in accordance with the provisions of Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800).

Subsurface testing of the project areas resulted in the identification of three archaeological sites, 33 PO 558-560. Based on the information presented in the report we agree that these sites do not meet the criteria for listing on the National Register of Historic Places. We concur that that no historic properties will be affected by the proposed construction. No further investigation is necessary unless the scope of the project changes or historic properties are accidentally discovered.

If you have any questions concerning this matter, please contact me at (614) 298-2043 or through e-mail, jquinlan@ohiohistory.org.

Sincerely,

Julie Quinlan, Program Reviews Manager
Resource Protection and Review

Reference 1009586

OHIO HISTORICAL SOCIETY
Ohio Historic Preservation Office
567 East Hudson Street, Columbus, Ohio 43211-1030 ph: 614.298.2000 fx: 614.298.2037
www.ohiohistory.org

STATE OF OHIO
ADJUTANT GENERAL'S DEPARTMENT
2825 West Dublin Granville Road
Columbus, Ohio 43235-2789

NGOH-IMR-ENV 18 February 2016

MEMORANDUM FOR RECORD

SUBJECT: Native American Consultation regarding proposed Continental United States Interceptor Site (CIS) at Camp Ravenna Joint Military Training Center (CRJMTC)

1. The Missile Defense Agency (MDA), in cooperation with the Ohio Army National Guard (OHARNG), is preparing an Environmental Impact Statement (EIS) to evaluate additional locations in the United States best suited for future deployment of a Continental United States Interceptor Site (CIS) capable of protecting the homeland against threats from nations such as North Korea and Iran. CRJMTC is one of four sites being considered for this action. The proposed project location and surrounding area at CRJMTC has been surveyed for archaeological resources. If CRJMTC is selected for the CIS, four of CRJMTC training site facilities will have to be relocated. Archaeological surveys have been completed within and around the relocation areas as well. Since 1997, nine archaeological surveys were completed within the proposed CIS project area and the four proposed facility relocation areas. From these 9 surveys, 35 archaeological sites are within the APE for this undertaking. None of these sites meet the eligibility criteria for listing on the National Register of Historic Places (NRHP) and no further work is recommended. The Ohio Historic Preservation Office (OHPO) concurred with these findings. In addition, the OHARNG consulted with Federally Recognized Tribes regarding the findings of these surveys.

2. The OHARNG considered the Annotated DoD Policy on American Indians and Alaska Natives (27 October 1999), EO 13175, AR 200-1 and guidance in DA PAM 200-4, Appendix F, while developing the EIS for this undertaking. Fifteen Native American groups have been identified as having possible ancestral ties to the CRJMTC area. These groups include the Cayuga, Chippewa, Delaware, Kickapoo, Miami, Mohawk, Oneida, Onondaga, Ottawa, Potawatomi, Sac & Fox, Seneca, Shawnee, Tuscarora, and Wyandotte. These groups were identified based on tribal consultation, personal correspondence with Native Americans, and research by the OHARNG cultural resources manager.

3. From the 14 identified Native American groups, 50 federally recognized tribes were invited by letter to consult in August 2014. Certified letters, signed by Major General Deborah Ashenhurst, OHARNG Adjutant General (TAG), to the leaders and cultural resources contacts of 50 tribes. On 6 November 2014, follow-up letters were sent to the same 50 tribes to update the tribes on the proposed undertaking and provide results on a recent archaeological survey completed within the proposed project area. The Seneca Nation expressed interest in results of archaeological surveys which they were provided copies. The Mille Lacs Band of Ojibwe determined that they do not have any known sites of religious or cultural importance in the CRJMTC area. The Kickapoo

Tribe of Oklahoma has no objections to the proposed project however requested being contacted in the event of an inadvertent discovery. The Delaware Tribe has no religious or culturally significant sites in the proposed project area and has no objection to the proposed project however they request being contacted in the event of an inadvertent discovery. The Delaware Nation believe their people may have occupied the area prehisotorically or historically however the proposed project location does not endanger cultural or religious sites of interest to the Delaware. The Delaware also request to be contacted in the event of an inadvertent discovery. The Nottawaseppi Huron Band of the Potawatomi requested copies of all archaeological surveys completed within and near the proposed project areas. Electronic copies of all reports were provided to the tribe and no objections or concerns regarding the proposed project or surveys has been received.

4. The OHARNG has established a good working relationship with tribes that have interest in OHARNG owned properties. Consultation with tribes has shown that the greatest interest is the inadvertent discovery of human remains or NAGPRA related items and results of archaeological surveys. In the event of an inadvertent discovery of human remains or funerary items, the OHARNG will follow *Procedures for Inadvertent Discovery of Cultural Materials at Camp Ravenna Joint Military Training Center*. These procedures were taken from Standard Operating Procedure #6 of the OHARNG Integrated Cultural Resources Management Plan and modified specifically for CRJMTC.

5. A list of POCs for each tribe contacted and copies of pertinent correspondence letters and e-mails can be found in the appendix of the EIS or obtained from the OHARNG cultural resources manager.

6. Any questions or concerns regarding Native American Consultation for CRJMTC should be directed to the undersigned at DSN 346-6569 or (614) 336-6569. The undersigned can also be contacted via e-mail at kimberly.s.ludt.nfg@mail.mil.

//////S//////
KIMBERLY S. LUDT
OHARNG Cultural Resources Manager

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APPENDIX F

SOCIOECONOMICS SUPPORTING INFORMATION

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Appendix F.1

FCTC Sites - Socioeconomics RIMS II Data Tables

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Table F.1
Indirect Impacts - Construction - FCTC Socioeconomic Projections

Ref	Industry	2015 Estimated Material Cost By Component *		2015 Labor Cost (Hours x BLS Prev. Wage Rate)	Earnings Adjustment for Regional Workers	Material Plus Labor	Material Plus Labor ($2010)	BEA RIMS II Multiplier				Projected Regional Economic Impacts**			
								Final Demand				Final Demand			
								Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)	Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)
1	Utilities	Sitework & Utilities	$65,372,411	$31,923,730	$11,173,305	$76,545,716	$70,422,059	1.2591	0.2178	3.5518	0.8477	$96,378,711	$16,671,657	250	$64,887,804
2	Construction	Power & Heating Plant	$46,119,586	$3,906,524	$1,367,283	$47,486,869	$43,687,920	1.6688	0.4926	13.5136	0.9085	$79,246,087	$23,392,032	590	$43,141,821
3	Construction	BMDS Command & Support Center Complex	$11,257,458	$1,895,861	$663,551	$11,921,009	$10,967,329	1.6688	0.4926	13.5136	0.9085	$19,893,781	$5,872,289	148	$10,830,237
4	Construction	Interceptor Monitoring Facility	$6,027,104	$1,059,405	$370,792	$6,397,896	$5,886,064	1.6688	0.4926	13.5136	0.9085	$10,676,809	$3,151,604	80	$5,812,488
5	Construction	Security Monitoring Facility	$4,219,854	$731,049	$255,867	$4,475,721	$4,117,663	1.6688	0.4926	13.5136	0.9085	$7,469,083	$2,204,740	56	$4,066,193
6	Construction	RIDT Utility Building	$3,247,374	$567,452	$198,608	$3,445,982	$3,170,304	1.6688	0.4926	13.5136	0.9085	$5,750,655	$1,697,491	43	$3,130,675
7	Construction	Administration & Maintenance Facility	$8,010,028	$1,564,375	$547,531	$8,557,559	$7,872,954	1.6688	0.4926	13.5136	0.9085	$14,280,855	$4,215,454	106	$7,774,543
8	Construction	Shipping & Receiving Facility	$1,065,853	$257,108	$89,988	$1,155,841	$1,063,374	1.6688	0.4926	13.5136	0.9085	$1,928,867	$569,367	14	$1,050,081
9	Construction	Logistics Warehouse	$2,857,221	$666,289	$233,201	$3,090,422	$2,843,188	1.6688	0.4926	13.5136	0.9085	$5,157,296	$1,522,342	38	$2,807,648
10	Construction	Water Supply Building	$1,426,797	$288,412	$100,944	$1,527,741	$1,405,522	1.6688	0.4926	13.5136	0.9085	$2,549,495	$752,565	19	$1,387,953
11	Construction	Waste Water Treatment Facility	$592,156	$126,090	$44,132	$636,288	$585,385	1.6688	0.4926	13.5136	0.9085	$1,061,837	$313,435	8	$578,067
12	Construction	Entry Control Facility	$2,174,012	$380,053	$133,019	$2,307,031	$2,122,468	1.6688	0.4926	13.5136	0.9085	$3,849,973	$1,136,443	29	$2,095,937
13	Construction	Missile Assembly Building	$32,481,884	$894,061	$312,921	$32,794,805	$30,171,221	1.6688	0.4926	13.5136	0.9085	$54,727,971	$16,154,721	408	$29,794,081
14	Construction	EKV Fuel Tank Storage Facility	$210,316	$53,049	$18,567	$228,883	$210,572	1.6688	0.4926	13.5136	0.9085	$381,960	$112,748	3	$207,940
15	Construction	EKV Oxidizer Tank Storage Facility	$181,373	$55,548	$19,442	$200,815	$184,750	1.6688	0.4926	13.5136	0.9085	$335,120	$98,921	2	$182,440
16	Construction	Interceptor Storage Facility	$956,537	$220,607	$77,212	$1,033,749	$951,049	1.6688	0.4926	13.5136	0.9085	$1,725,121	$509,225	13	$939,161
17	Construction	Interceptor Field	$7,240,291	$1,135,231	$397,331	$7,637,622	$7,026,612	1.6688	0.4926	13.5136	0.9085	$12,745,663	$3,762,293	95	$6,938,779
18	Construction	Mechanical / Electrical Building	$4,477,219	$1,363,827	$477,339	$4,954,558	$4,558,194	1.6688	0.4926	13.5136	0.9085	$8,268,167	$2,440,615	62	$4,501,216
19	Construction	IDT Facility / IDT Support Building Complex	$3,128,705	$1,072,834	$375,492	$3,504,197	$3,223,861	1.6688	0.4926	13.5136	0.9085	$5,847,804	$1,726,167	44	$3,183,563
Total			**$201,046,179**	**48,161,505**	**$16,856,527**	**$217,902,706**	**$200,470,489**					**$332,275,256**	**$86,304,110**	**2,008**	**$193,310,629**

*All material costs are taken from a similarly sized government project operated in Fort Greely, AK starting on 1/24/2011

** Projected economic impact calculations would apply to the region around the project site, including Kalamazoo, Calhoun, Bary, Eaton, and Ingham Counties

Source: Bureau of Labor Statistics 2013

Page 1 of 2

Table F.1

Indirect Impacts - Operation - FCTC Socioeconomic Projections

Ref	Industry	Estimated Material Cost/Year *		Material Plus Labor ($2010)	BEA RIMS II Multiplier – Final Demand: Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)	Projected Regional Economic Impacts/Year** – Final Demand: Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)
1	Services	Common use Facility, Construction, Operations, Maintenance and Repair	$1,925,000	$1,771,000	1.7298	0.5631	18.1189	0.9963	$3,329,865	$1,083,968	32	$1,917,878
2	Telecommunications	Communications Services	$669,290	$615,747	1.3855	0.2214	5.3375	0.8039	$927,301	$148,181	3	$538,042
3	Services	Custodial Service	$278,000	$255,760	1.7298	0.5631	18.1189	0.9963	$480,884	$156,542	5	$276,971
4	Professional, Scientific, and Technical Services	Entomology	$36,000	$33,120	1.6427	0.5887	12.8185	1.1089	$59,137	$21,193	0	$39,920
5	Professional, Scientific, and Technical Services	Environmental Clean-up	$100,000	$92,000	1.6427	0.5887	12.8185	1.1089	$164,270	$58,870	1	$110,890
6	Professional, Scientific, and Technical Services	Environmental Compliance	$200,000	$184,000	1.6427	0.5887	12.8185	1.1089	$328,540	$117,740	2	$221,780
7	Services	Explosive Ordinance Support	$10,000	$9,200	1.7298	0.5631	18.1189	0.9963	$17,298	$5,631	0	$9,963
8	Services	Facility Major Repair	$500,000	$460,000	1.7298	0.5631	18.1189	0.9963	$864,900	$281,550	8	$498,150
9	Services	Facility Maintenance and Minor Repair	$9,819,953	$9,034,357	1.7298	0.5631	18.1189	0.9963	$16,986,555	$5,529,616	164	$9,783,619
10	Services	Finance and Accounting	$5,000	$4,600	1.7298	0.5631	18.1189	0.9963	$8,649	$2,816	0	$4,982
11	Services	Fire Protection	$3,000	$2,760	1.7298	0.5631	18.1189	0.9963	$5,189	$1,689	0	$2,989
12	Services	Housing and Lodging	$1,558,920	$1,434,206	1.7298	0.5631	18.1189	0.9963	$2,696,620	$877,828	26	$1,553,152
13	Services	Purchasing and Contracting Services	$399,000	$367,080	1.7298	0.5631	18.1189	0.9963	$690,190	$224,677	7	$397,524
14	Services	Refuse Collection and Disposal	$19,678	$18,104	1.7298	0.5631	18.1189	0.9963	$34,039	$11,081	0	$19,605
15	Services	Resource Management	$266,000	$244,720	1.7298	0.5631	18.1189	0.9963	$460,127	$149,785	4	$265,016
16	Services	Safety (based on actual labor costs)	$2,000	$1,840	1.7298	0.5631	18.1189	0.9963	$3,460	$1,126	0	$1,993
17	Services	Security Services (accessing control point guard)	$2,000,000	$1,840,000	1.7298	0.5631	18.1189	0.9963	$3,459,600	$1,126,200	33	$1,992,600
18	Transit and Ground Passenger Transportation	Shuttle Service	$600,000	$552,000	1.5210	0.5190	20.1024	1.0111	$912,600	$311,400	11	$606,660
19	Warehousing and Storage	Storage and Warehousing	$2,000	$1,840	1.6697	0.5819	15.8170	1.1446	$3,339	$1,164	0	$2,289
20	Services	Supply Services	$466,000	$428,720	1.7298	0.5631	18.1189	0.9963	$806,087	$262,405	8	$464,276
21	Other Transportation and Support Activities	Transportation Services	$70,762	$65,101	1.5621	0.5414	13.6871	1.0359	$110,537	$38,311	1	$73,302
22	Utilities	Utilities	$1,840,699	$1,693,443	1.2591	0.2178	3.5518	0.8477	$2,317,624	$400,904	6	$1,560,361
23	Other Transportation and Support Activities	Vehicle Support	$25,000	$23,000	1.5621	0.5414	13.6871	1.0359	$39,053	$13,535	0	$25,898
24	Services	Additional Services: Aerial Photography	$9,394	$8,642	1.7298	0.5631	18.1189	0.9963	$16,250	$5,290	0	$9,359
25	Household Earnings	Wages Paid to CIS Staff	$21,525,000	$16,832,550	0.7372	0.2171	6.0784	0.4589	$13,487,996	$3,972,116	102	$8,396,149
Total			**$20,805,696**	(not incl. hshold earnings)					**$48,210,110**	**$14,803,615**	**416**	**$28,773,367**

*All material costs are taken from a similarly sized government project operated in Fort Greely, AK starting on 1/24/201

** Projected economic impact calculations would apply to the region around the project site, including Kalamazoo, Calhoun, Bary, Eaton, and Ingham Countie

Source of Multipliers: Bureau of Labor Statistics 2013

Appendix F.2

CRJMTC - Socioeconomics RIMS II Data Tables

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Table F.2
Indriect Impacts - Construction - CRJMTC Socioeconomic Projections

Ref	Industry	2015 Estimated Material Cost By Component*		2015 Labor Cost (Hours x BLS Prev. Wage Rate)	Earnings Adjustment for Regional Workers	Material Plus Labor	Material Plus Labor ($2010)	BEA RIMS II Multiplier				Projected Regional Economic Impacts**			
								Final Demand				Final Demand			
								Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)	Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)
1	Utilities	Sitework & Utilities	$65,372,411	$31,923,730	$11,173,305	$76,545,716	$70,422,059	1.318	0.2325	3.9949	0.8829	$100,887,254	$17,796,879	281	$67,582,213
2	Construction	Power & Heating Plant	$46,119,586	$3,906,524	$1,367,283	$47,486,869	$43,687,920	2.0336	0.6162	15.9161	1.1103	$96,569,297	$29,261,409	695	$52,724,671
3	Construction	BMDS Command & Support Center Complex	$11,257,458	$1,895,861	$663,551	$11,921,009	$10,967,329	2.0336	0.6162	15.9161	1.1103	$24,242,565	$7,345,726	175	$13,235,897
4	Construction	Interceptor Monitoring Facility	$6,027,104	$1,059,405	$370,792	$6,397,896	$5,886,064	2.0336	0.6162	15.9161	1.1103	$13,010,761	$3,942,383	94	$7,103,584
5	Construction	Security Monitoring Facility	$4,219,854	$731,049	$255,867	$4,475,721	$4,117,663	2.0336	0.6162	15.9161	1.1103	$9,101,826	$2,757,939	66	$4,969,393
6	Construction	RIDT Utility Building	$3,247,374	$567,452	$198,608	$3,445,982	$3,170,304	2.0336	0.6162	15.9161	1.1103	$7,007,750	$2,123,414	50	$3,826,074
7	Construction	Administration & Maintenance Facility	$8,010,028	$1,564,375	$547,531	$8,557,559	$7,872,954	2.0336	0.6162	15.9161	1.1103	$17,402,652	$5,273,168	125	$9,501,458
8	Construction	Shipping & Receiving Facility	$1,065,853	$257,108	$89,988	$1,155,841	$1,063,374	2.0336	0.6162	15.9161	1.1103	$2,350,518	$712,229	17	$1,283,330
9	Construction	Logistics Warehouse	$2,857,221	$666,289	$233,201	$3,090,422	$2,843,188	2.0336	0.6162	15.9161	1.1103	$6,284,682	$1,904,318	45	$3,431,296
10	Construction	Water Supply Building	$1,426,797	$288,412	$100,944	$1,527,741	$1,405,522	2.0336	0.6162	15.9161	1.1103	$3,106,815	$941,394	22	$1,696,251
11	Construction	Waste Water Treatment Facility	$592,156	$126,090	$44,132	$636,288	$585,385	2.0336	0.6162	15.9161	1.1103	$1,293,955	$392,080	9	$706,470
12	Construction	Entry Control Facility	$2,174,012	$380,053	$133,019	$2,307,031	$2,122,468	2.0336	0.6162	15.9161	1.1103	$4,691,578	$1,421,592	34	$2,561,496
13	Construction	Missile Assembly Building	$32,481,884	$894,061	$312,921	$32,794,805	$30,171,221	2.0336	0.6162	15.9161	1.1103	$66,691,516	$20,208,159	480	$36,412,072
14	Construction	EKV Fuel Tank Storage Facility	$210,316	$53,049	$18,567	$228,883	$210,572	2.0336	0.6162	15.9161	1.1103	$465,457	$141,038	3	$254,129
15	Construction	EKV Oxidizer Tank Storage Facility	$181,373	$55,548	$19,442	$200,815	$184,750	2.0336	0.6162	15.9161	1.1103	$408,377	$123,742	3	$222,965
16	Construction	Interceptor Storage Facility	$956,537	$220,607	$77,212	$1,033,749	$951,049	2.0336	0.6162	15.9161	1.1103	$2,102,233	$636,996	15	$1,147,772
17	Construction	Interceptor Field	$7,240,291	$1,135,231	$397,331	$7,637,622	$7,026,612	2.0336	0.6162	15.9161	1.1103	$15,531,868	$4,706,303	112	$8,480,052
18	Construction	Mechanical / Electrical Building	$4,477,219	$1,363,827	$477,339	$4,954,558	$4,558,194	2.0336	0.6162	15.9161	1.1103	$10,075,590	$3,052,999	73	$5,501,046
19	Construction	IDT Facility / IDT Support Building Complex	$3,128,705	$1,072,834	$375,492	$3,504,197	$3,223,861	2.0336	0.6162	15.9161	1.1103	$7,126,135	$2,159,286	51	$3,890,710
Total			**$201,046,179**	**48,161,505**	**$32,794,805**	**$233,840,984**	**$215,133,706**					**$388,350,828**	**$104,901,056**	**2,351**	**$224,530,878**

*All material costs are taken from a similarly sized government project operated in Fort Greely, AK starting on 1/24/2011

** Projected economic impact calculations would apply to the region around the project site, including Portage, Trumbull, Mahoning, Summit, Cuyahoga, Geauga, and Stark Counties

Source: Bureau of Labor Statistics 2013

Table F.2
Indirect Impacts - Operation - CRJMTC Socioeconomic Projections

Ref	Industry	Estimated Material Cost/Year*		Material Plus Relocating Labor ($2010)	BEA RIMS II Multiplier				Projected Regional Economic Impacts/Year**			
					Final Demand				Final Demand			
					Output (dollars)	Earnings (dollars)	Employment (jobs)	Value-Added (dollars)	Output (dollars)	Earnings (dollars)	Employment (jobs)	Value-Added (dollars)
1	Services	Common use Facility, Construction, Operations, Maintenance and Repair	$1,925,000	$1,771,000	1.5800	0.5340	13.3236	0.9054	$3,041,500	$1,027,950	24	$1,742,895
2	Telecommunications	Communications Services	$669,290	$615,747	1.3005	0.2369	4.0867	0.7515	$870,412	$158,555	3	$502,971
3	Services	Custodial Service	$278,000	$255,760	1.5800	0.5340	13.3236	0.9054	$439,240	$148,452	3	$251,701
4	Professional, Scientific, and Technical Services	Entomology	$36,000	$33,120	1.5169	0.6549	11.2410	1.0331	$54,608	$23,576	0	$37,192
5	Professional, Scientific, and Technical Services	Environmental Clean-up	$100,000	$92,000	1.5169	0.6549	11.2410	1.0331	$151,690	$65,490	1	$103,310
6	Professional, Scientific, and Technical Services	Environmental Compliance	$200,000	$184,000	1.5169	0.6549	11.2410	1.0331	$303,380	$130,980	2	$206,620
7	Services	Explosive Ordinance Support	$10,000	$9,200	1.5800	0.5340	13.3236	0.9054	$15,800	$5,340	0	$9,054
8	Services	Facility Major Repair	$500,000	$460,000	1.5800	0.5340	13.3236	0.9054	$790,000	$267,000	6	$452,700
9	Services	Facility Maintenance and Minor Repair	$9,819,953	$9,034,357	1.5800	0.5340	13.3236	0.9054	$15,515,526	$5,243,855	120	$8,890,985
10	Services	Finance and Accounting	$5,000	$4,600	1.5800	0.5340	13.3236	0.9054	$7,900	$2,670	0	$4,527
11	Services	Fire Protection	$3,000	$2,760	1.5800	0.5340	13.3236	0.9054	$4,740	$1,602	0	$2,716
12	Services	Housing and Lodging	$1,558,920	$1,434,206	1.5800	0.5340	13.3236	0.9054	$2,463,094	$832,463	19	$1,411,446
13	Services	Purchasing and Contracting Services	$399,000	$367,080	1.5800	0.5340	13.3236	0.9054	$630,420	$213,066	5	$361,255
14	Services	Refuse Collection and Disposal	$19,678	$18,104	1.5800	0.5340	13.3236	0.9054	$31,091	$10,508	0	$17,816
15	Services	Resource Management	$266,000	$244,720	1.5800	0.5340	13.3236	0.9054	$420,280	$142,044	3	$240,836
16	Services	Safety (based on actual labor costs)	$2,000	$1,840	1.5800	0.5340	13.3236	0.9054	$3,160	$1,068	0	$1,811
17	Services	Security Services (accessing control point guard)	$2,000,000	$1,840,000	1.5800	0.5340	13.3236	0.9054	$3,160,000	$1,068,000	25	$1,810,800
18	Transit and Ground Passenger Transportation	Shuttle Service	$600,000	$552,000	1.4460	0.6242	22.9948	0.9778	$867,600	$374,520	13	$586,680
19	Warehousing and Storage	Storage and Warehousing	$2,000	$1,840	1.4682	0.5832	16.4183	1.0215	$2,936	$1,166	0	$2,043
20	Services	Supply Services	$466,000	$428,720	1.5800	0.5340	13.3236	0.9054	$736,280	$248,844	6	$421,916
21	Other Transportation and Support Activities	Transportation Services	$70,762	$65,101	1.5040	0.6107	13.4974	1.0059	$106,426	$43,214	1	$71,179
22	Utilities	Utilities	$1,840,699	$1,693,443	1.2331	0.2496	3.3958	0.8324	$2,269,766	$459,438	6	$1,532,198
23	Other Transportation and Support Activities	Vehicle Support	$25,000	$23,000	1.5040	0.6107	13.4974	1.0059	$37,600	$15,268	0	$25,148
24	Services	Additional Services: Aerial Photography	$9,394	$8,642	1.5800	0.5340	13.3236	0.9054	$14,843	$5,016	0	$8,505
25	Household Earnings	Wages Paid to CIS Staff	$21,525,000	$16,832,550	0.7372	0.2171	6.0784	0.4589	$13,487,996	$3,972,116	102	$8,396,149
Total			**$20,805,696**	(not incl. hshold earnings)					**$45,426,287**	**$14,462,202**	**340**	**$27,092,455**

*All material costs are taken from a similarly sized government project operated in Fort Greely, AK starting on 1/24/201

** Projected economic impact calculations would apply to the region around the project site, including Portage, Trumbull, Mahoning, Summit, Cuyahoga, Geauga, and Stark Countie

Source of Multipliers: Bureau of Labor Statistics 201

Page 2 of 2

Appendix F.3

FTD - Socioeconomics RIMS II Data Tables

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Table F.3
Indirect Impacts - Construction - FTD Socioeconomic Projections

Ref	Industry	2015 Estimated Material Cost By Component*		2015 Labor Cost (Hours x BLS Prev. Wage Rate)	Adjustment for Regional Workers	Material Plus Labor	Material Plus Labor ($2010)	BEA RIMS II Multiplier				Projected FTD Regional Economic Impacts**			
								Final Demand				Final Demand			
								Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)	Output (dollars)	Earnings (dollars)	Employ-ment (jobs)	Value-Added (dollars)
1	Utilities	Sitework & Utilities	$65,372,411	$31,923,730	$15,961,865	$81,334,276	$74,827,534	1.2331	0.2496	3.3958	0.8324	$100,293,295	$20,301,035	254	$67,702,651
2	Construction	Power & Heating Plant	$46,119,586	$3,906,524	$1,953,262	$48,072,848	$44,227,020	1.5660	0.5631	11.9602	0.8530	$75,282,080	$27,069,821	529	$41,006,139
3	Construction	BMDS Command & Support Center Complex	$11,257,458	$1,895,861	$947,931	$12,205,389	$11,228,958	1.5660	0.5631	11.9602	0.8530	$19,113,639	$6,872,854	134	$10,411,196
4	Construction	Interceptor Monitoring Facility	$6,027,104	$1,059,405	$529,703	$6,556,807	$6,032,262	1.5660	0.5631	11.9602	0.8530	$10,267,959	$3,692,138	72	$5,592,956
5	Construction	Security Monitoring Facility	$4,219,854	$731,049	$365,524	$4,585,378	$4,218,548	1.5660	0.5631	11.9602	0.8530	$7,180,703	$2,582,027	50	$3,911,328
6	Construction	RIDT Utility Building	$3,247,374	$567,452	$283,726	$3,531,100	$3,248,612	1.5660	0.5631	11.9602	0.8530	$5,529,703	$1,988,362	39	$3,012,028
7	Construction	Administration & Maintenance Facility	$8,010,028	$1,564,375	$782,187	$8,792,215	$8,088,838	1.5660	0.5631	11.9602	0.8530	$13,768,609	$4,950,896	97	$7,499,760
8	Construction	Shipping & Receiving Facility	$1,065,853	$257,108	$128,554	$1,194,407	$1,098,855	1.5660	0.5631	11.9602	0.8530	$1,870,442	$672,571	13	$1,018,829
9	Construction	Logistics Warehouse	$2,857,221	$666,289	$333,144	$3,190,365	$2,935,136	1.5660	0.5631	11.9602	0.8530	$4,996,112	$1,796,495	35	$2,721,382
10	Construction	Water Supply Building	$1,426,797	$288,412	$144,206	$1,571,003	$1,445,323	1.5660	0.5631	11.9602	0.8530	$2,460,191	$884,632	17	$1,340,066
11	Construction	Waste Water Treatment Facility	$592,156	$126,090	$63,045	$655,201	$602,785	1.5660	0.5631	11.9602	0.8530	$1,026,045	$368,944	7	$558,887
12	Construction	Entry Control Facility	$2,174,012	$380,053	$190,027	$2,364,039	$2,174,916	1.5660	0.5631	11.9602	0.8530	$3,702,085	$1,331,190	26	$2,016,525
13	Construction	Missile Assembly Building	$32,481,884	$894,061	$447,030	$32,928,914	$30,294,601	1.5660	0.5631	11.9602	0.8530	$51,566,680	$18,542,272	362	$28,088,364
14	Construction	EKV Fuel Tank Storage Facility	$210,316	$53,049	$26,524	$236,840	$217,893	1.5660	0.5631	11.9602	0.8530	$370,892	$133,365	3	$202,025
15	Construction	EKV Oxidizer Tank Storage Facility	$181,373	$55,548	$27,774	$209,147	$192,415	1.5660	0.5631	11.9602	0.8530	$327,524	$117,771	2	$178,402
16	Construction	Interceptor Storage Facility	$956,537	$220,607	$110,303	$1,066,840	$981,493	1.5660	0.5631	11.9602	0.8530	$1,670,672	$600,738	12	$910,015
17	Construction	Interceptor Field	$7,240,291	$1,135,231	$567,616	$7,807,907	$7,183,274	1.5660	0.5631	11.9602	0.8530	$12,227,182	$4,396,632	86	$6,660,144
18	Construction	Mechanical / Electrical Building	$4,477,219	$1,363,827	$681,913	$5,159,132	$4,746,402	1.5660	0.5631	11.9602	0.8530	$8,079,201	$2,905,107	57	$4,400,740
19	Construction	IDT Facility / IDT Support Building Complex	$3,128,705	$1,072,834	$536,417	$3,665,122	$3,371,912	1.5660	0.5631	11.9602	0.8530	$5,739,581	$2,063,830	40	$3,126,349
Total			**$201,046,179**	**48,161,505**	**$24,080,753**	**$225,126,932**	**$207,116,777**					**$325,472,595**	**$101,270,680**	**1,836**	**$190,357,787**

*All material costs are taken from a similarly sized government project operated in Fort Greely, AK starting on 1/24/2011

** Projected economic impact calculations would apply to the region around the project site, including Jefferson, St. Lawrence, and Lewis in New York

Source: Bureau of Labor Statistics 2013

Table F.3
Indirect Impacts - Operation - FTD Socioeconomic Projections

Ref	Industry	2015 Estimated Material Cost By Component*		Material Plus Labor ($2010)	BEA RIMS II Multiplier, Final Demand: Output (dollars)	BEA RIMS II Multiplier, Final Demand: Earnings (dollars)	BEA RIMS II Multiplier, Final Demand: Employ-ment (jobs)	BEA RIMS II Multiplier, Final Demand: Value-Added (dollars)	Projected Regional Economic Impacts/Year**, Final Demand: Output (dollars)	Projected Regional Economic Impacts/Year**, Final Demand: Earnings (dollars)	Projected Regional Economic Impacts/Year**, Final Demand: Employ-ment (jobs)	Projected Regional Economic Impacts/Year**, Final Demand: Value-Added (dollars)
1	Services	Common use Facility, Construction, Operations, Maintenance and Repair	$1,925,000	$1,771,000	1.5800	0.5340	13.3236	0.9054	$3,041,500	$1,027,950	24	$1,742,895
2	Telecommunications	Communications Services	$669,290	$615,747	1.3005	0.2369	4.0867	0.7515	$870,412	$158,555	3	$502,971
3	Services	Custodial Service	$278,000	$255,760	1.5800	0.5340	13.3236	0.9054	$439,240	$148,452	3	$251,701
4	Professional, Scientific, and Technical Services	Entomology	$36,000	$33,120	1.5169	0.6549	11.2410	1.0331	$54,608	$23,576	0	$37,192
5	Professional, Scientific, and Technical Services	Environmental Clean-up	$100,000	$92,000	1.5169	0.6549	11.2410	1.0331	$151,690	$65,490	1	$103,310
6	Professional, Scientific, and Technical Services	Environmental Compliance	$200,000	$184,000	1.5169	0.6549	11.2410	1.0331	$303,380	$130,980	2	$206,620
7	Services	Explosive Ordinance Support	$10,000	$9,200	1.5800	0.5340	13.3236	0.9054	$15,800	$5,340	0	$9,054
8	Services	Facility Major Repair	$500,000	$460,000	1.5800	0.5340	13.3236	0.9054	$790,000	$267,000	6	$452,700
9	Services	Facility Maintenance and Minor Repair	$9,819,953	$9,034,357	1.5800	0.5340	13.3236	0.9054	$15,515,526	$5,243,855	120	$8,890,985
10	Services	Finance and Accounting	$5,000	$4,600	1.5800	0.5340	13.3236	0.9054	$7,900	$2,670	0	$4,527
11	Services	Fire Protection	$3,000	$2,760	1.5800	0.5340	13.3236	0.9054	$4,740	$1,602	0	$2,716
12	Services	Housing and Lodging	$1,558,920	$1,434,206	1.5800	0.5340	13.3236	0.9054	$2,463,094	$832,463	19	$1,411,446
13	Services	Purchasing and Contracting Services	$399,000	$367,080	1.5800	0.5340	13.3236	0.9054	$630,420	$213,066	5	$361,255
14	Services	Refuse Collection and Disposal	$19,678	$18,104	1.5800	0.5340	13.3236	0.9054	$31,091	$10,508	0	$17,816
15	Services	Resource Management	$266,000	$244,720	1.5800	0.5340	13.3236	0.9054	$420,280	$142,044	3	$240,836
16	Services	Safety (based on actual labor costs)	$2,000	$1,840	1.5800	0.5340	13.3236	0.9054	$3,160	$1,068	0	$1,811
17	Services	Security Services (accessing control point guard)	$2,000,000	$1,840,000	1.5800	0.5340	13.3236	0.9054	$3,160,000	$1,068,000	25	$1,810,800
18	Transit and Ground Passenger Transportation	Shuttle Service	$600,000	$552,000	1.4460	0.6242	22.9948	0.9778	$867,600	$374,520	13	$586,680
19	Warehousing and Storage	Storage and Warehousing	$2,000	$1,840	1.4682	0.5832	16.4183	1.0215	$2,936	$1,166	0	$2,043
20	Services	Supply Services	$466,000	$428,720	1.5800	0.5340	13.3236	0.9054	$736,280	$248,844	6	$421,916
21	Other Transportation and Support Activities	Transportation Services	$70,762	$65,101	1.5040	0.6107	13.4974	1.0059	$106,426	$43,214	1	$71,179
22	Utilities	Utilities	$1,840,699	$1,693,443	1.2331	0.2496	3.3958	0.8324	$2,269,766	$459,438	6	$1,532,198
23	Other Transportation and Support Activities	Vehicle Support	$25,000	$23,000	1.5040	0.6107	13.4974	1.0059	$37,600	$15,268	0	$25,148
24	Services	Additional Services: Aerial Photography	$9,394	$8,642	1.5800	0.5340	13.3236	0.9054	$14,843	$5,016	0	$8,505
25	Household Earnings	Wages Paid to CIS Staff	$21,525,000	$16,832,550	0.7372	0.2171	6.0784	0.4589	$13,487,996	$3,972,116	102	$8,396,149
Total			**$20,805,696**	(not incl. hshold earnings)					**$45,426,287**	**$14,462,202**	**340**	**$27,092,455**

*All material costs are taken from a similarly sized government project operated in Fort Greely, AK starting on 1/24/2011

** Projected economic impact calculations would apply to the region around the project site, including Jefferson, St. Lawrence, and Lewis in New York.

Source of Multipliers: Bureau of Labor Statistics 2013

APPENDIX G

TRANSPORTATION SUPPORTING INFORMATION

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Appendix G.1

FCTC Sites

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HCS Analysis Results

For FCTC Site 1

Exit 92

Intersections on Southside & Northside of Interstate

Existing Traffic Condition

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                   HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY__________________________

Analyst:               Kevin Harder
Agency/Co.:            B&V
Date Performed:        10/15/2015
Analysis Time Period: AM Peak Hour - Existing
Intersection:          I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:         2015
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:      I-94 EB Off Ramp
North/South Street:    I-94BL
Intersection Orientation: NS                Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                             200    52       116    148
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              200    52       116    148
Percent Heavy Vehicles             --     --       28     --     --
Median Type/Storage         Undivided             /
RT Channelized?                           No
Lanes                              1    1             1   1
Configuration                      T   R               L  T
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      4             532
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       4             532
Percent Heavy Vehicles      50            4
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage                /                      /
Lanes                           1        1
Configuration                    L      R
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach            NB     SB        Westbound            Eastbound
Movement            1      4    |  7      8      9    |  10     11     12
Lane Config                L    |  L             R    |
______________________________________________________________________________
v (vph)                    116    4              532
C(m) (vph)                 1176   353            831
v/c                        0.10   0.01           0.64
95% queue length           0.33   0.03           5.16
Control Delay              8.4    15.3           17.0
LOS                         A      C              C
Approach Delay                           16.9
Approach LOS                              C
______________________________________________________________________________
```

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/15/2015
Analysis Time Period: AM Peak Hour - Existing
Intersection: I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street: I-94 EB Off Ramp
North/South Street: I-94BL
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L	2 T	3 R	4 L	5 T	6 R
Volume		200	52	116	148	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		50	13	29	37	
Hourly Flow Rate, HFR		200	52	116	148	
Percent Heavy Vehicles		--	--	28	--	--
Median Type/Storage	Undivided			/		
RT Channelized?			No			
Lanes		1	1	1	1	
Configuration		T	R	L	T	
Upstream Signal?		No			No	

Minor Street Movements	7 L	8 T	9 R	10 L	11 T	12 R
Volume	4		532			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	1		133			
Hourly Flow Rate, HFR	4		532			
Percent Heavy Vehicles	50		4			
Percent Grade (%)		1			0	
Flared Approach: Exists?/Storage			/			/
RT Channelized?			No			
Lanes	1		1			
Configuration	L		R			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		28	50		4			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.4	7.1		6.3			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		28	50		4			
t(f)		2.5	4.0		3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		252	580		200			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	200	
Potential Capacity	831	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	831	
Probability of Queue free St.	0.36	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	252	
Potential Capacity	1176	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1176	
Probability of Queue free St.	0.90	1.00
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	580	
Potential Capacity	392	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.90	0.33
Movement Capacity	353	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage	7	10
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage	7	10
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		

Result for 2 stage process:	7	10
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage	7	10
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage	7	10
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage	7	10
Conflicting Flows	580	
Potential Capacity	392	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.90	0.33
Movement Capacity	353	

Results for Two-stage process:	7	10
a		
y		
C t	353	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4		532			
Movement Capacity (vph)	353		831			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	353		831			
Volume	4		532			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		R			
v (vph)		116	4		532			
C(m) (vph)		1176	353		831			
v/c		0.10	0.01		0.64			
95% queue length		0.33	0.03		5.16			
Control Delay		8.4	15.3		17.0			
LOS		A	C		C			
Approach Delay				16.9				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.90
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		8.4
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

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_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       10/15/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection:         I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2015
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:     I-94 EB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

_____________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                             156    72       272    212
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              156    72       272    212
Percent Heavy Vehicles             --     --       9      --     --
Median Type/Storage         Undivided             /
RT Channelized?                         No
Lanes                              1    1             1    1
Configuration                      T    R              L   T
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      4             240
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       4             240
Percent Heavy Vehicles      0             7
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage               /                      /
Lanes                           1       1
Configuration                    L      R
______________________________________________________________________________

_________________Delay, Queue Length, and Level of Service___________________
Approach            NB     SB        Westbound              Eastbound
Movement            1      4   |  7      8      9     |  10     11     12
Lane Config                L   |  L             R     |
______________________________________________________________________________
v (vph)                    272    4             240
C(m) (vph)                 1300   230           873
v/c                        0.21   0.02          0.27
95% queue length           0.79   0.05          1.13
Control Delay              8.5    20.9          10.7
LOS                         A      C             B
Approach Delay                           10.9
Approach LOS                              B
______________________________________________________________________________
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                 HCS+: Unsignalized Intersections Release 5.6




Phone:                                              Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       10/15/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection:         I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2015
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:     I-94 EB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                            156    72     272    212
Peak-Hour Factor, PHF             1.00   1.00   1.00   1.00
Peak-15 Minute Volume             39     18     68     53
Hourly Flow Rate, HFR             156    72     272    212
Percent Heavy Vehicles            --     --     9      --     --
Median Type/Storage         Undivided             /
RT Channelized?                          No
Lanes                             1    1           1    1
Configuration                     T    R            L   T
Upstream Signal?                  No                    No
______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     4             240
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      1             60
Hourly Flow Rate, HFR      4             240
Percent Heavy Vehicles     0             7
Percent Grade (%)                 1                     0
Flared Approach:  Exists?/Storage                /                      /
RT Channelized?                          No
Lanes                         1        1
Configuration                  L      R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)			4.1	7.1		6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			9	0		7			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)			0.00	0.70		0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.2	6.6		6.4			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		9	0		7			
t(f)		2.3	3.5		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		228	912		156			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	156	
Potential Capacity	873	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	873	
Probability of Queue free St.	0.73	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	228	
Potential Capacity	1300	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1300	
Probability of Queue free St.	0.79	1.00
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.79	0.79
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	912	
Potential Capacity	291	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.79
Maj. L, Min T Adj. Imp Factor.		0.84
Cap. Adj. factor due to Impeding mvmnt	0.79	0.61
Movement Capacity	230	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.79	0.79
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	912	
Potential Capacity	291	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.79
Maj. L, Min T Adj. Imp Factor.		0.84
Cap. Adj. factor due to Impeding mvmnt	0.79	0.61
Movement Capacity	230	
Results for Two-stage process:		
a		
y		
C t	230	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4		240			
Movement Capacity (vph)	230		873			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	230		873			
Volume	4		240			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		R			
v (vph)		272	4		240			
C(m) (vph)		1300	230		873			
v/c		0.21	0.02		0.27			
95% queue length		0.79	0.05		1.13			
Control Delay		8.5	20.9		10.7			
LOS		A	C		B			
Approach Delay				10.9				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.79
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		8.5
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/15/2015
Analysis Time Period: AM Peak Hour - Existing
Intersection: I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street: I-94 WB Off Ramp
North/South Street: I-94BL
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1 L	2 T	3 R	4 L	5 T	6 R
Volume	16	704			220	240
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	16	704			220	240
Percent Heavy Vehicles	9	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						No
Lanes	1	1			1	1
Configuration	L	T			T	R
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume	64		304			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	64		304			
Percent Heavy Vehicles	8		9			
Percent Grade (%)		1			0	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	16		64		304			
C(m) (vph)	1065		220		417			
v/c	0.02		0.29		0.73			
95% queue length	0.05		1.21		7.16			
Control Delay	8.4		28.0		35.8			
LOS	A		D		E			
Approach Delay				34.5				
Approach LOS				D				

```
                    HCS+: Unsignalized Intersections Release 5.6



Phone:                                          Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       10/15/2015
Analysis Time Period: AM Peak Hour - Existing
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2015
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     16     704                  220    240
Peak-Hour Factor, PHF      1.00   1.00                 1.00   1.00
Peak-15 Minute Volume      4      176                  55     60
Hourly Flow Rate, HFR      16     704                  220    240
Percent Heavy Vehicles     9      --     --            --     --
Median Type/Storage         Undivided            /
RT Channelized?                                               No
Lanes                         1   1                    1    1
Configuration                  L  T                    T   R
Upstream Signal?                  No                   No
______________________________________________________________________________
Minor Street Movements      7      8      9     10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     64            304
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      16            76
Hourly Flow Rate, HFR      64            304
Percent Heavy Vehicles     8             9
Percent Grade (%)                 1                    0
Flared Approach:  Exists?/Storage               /                     /
RT Channelized?                          No
Lanes                         1        1
Configuration                  L      R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

```
Lane Width (ft)               12.0   12.0   12.0   12.0
Walking Speed (ft/sec)        4.0    4.0    4.0    4.0
Percent Blockage              0      0      0      0
______________________________________________________________________________

_____________________________Upstream Signal Data_____________________________
                 Prog.    Sat   Arrival   Green  Cycle   Prog.   Distance
                 Flow     Flow   Type     Time   Length  Speed   to Signal
                 vph      vph             sec     sec     mph      feet
______________________________________________________________________________
S2  Left-Turn
    Through
S5  Left-Turn
    Through
______________________________________________________________________________

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles
______________________________________________________________________________
                                             Movement 2     Movement 5
______________________________________________________________________________
Shared ln volume, major th vehicles:
Shared ln volume, major rt vehicles:
Sat flow rate, major th vehicles:
Sat flow rate, major rt vehicles:
Number of major street through lanes:
______________________________________________________________________________

Worksheet 4-Critical Gap and Follow-up Time Calculation
______________________________________________________________________________
Critical Gap Calculation
Movement           1      4      7      8      9     10     11     12
                   L      L      L      T      R      L      T      R
______________________________________________________________________________
t(c,base)        4.1           7.1           6.2
t(c,hv)          1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00
P(hv)            9             8             9
t(c,g)                         0.20   0.20   0.10   0.20   0.20   0.10
Percent Grade                  1.00   1.00   1.00   0.00   0.00   0.00
t(3,lt)          0.00          0.70          0.00
t(c,T):  1-stage 0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00
         2-stage 0.00   0.00   1.00   1.00   0.00   1.00   1.00   0.00
t(c)     1-stage 4.2           6.7           6.4
         2-stage
______________________________________________________________________________
Follow-Up Time Calculations
Movement           1      4      7      8      9     10     11     12
                   L      L      L      T      R      L      T      R
______________________________________________________________________________
t(f,base)        2.20          3.50          3.30
t(f,HV)          0.90   0.90   0.90   0.90   0.90   0.90   0.90   0.90
P(HV)            9             8             9
t(f)             2.3           3.6           3.4
______________________________________________________________________________

Worksheet 5-Effect of Upstream Signals
______________________________________________________________________________
Computation 1-Queue Clearance Time at Upstream Signal
                                              Movement 2        Movement 5
                                           V(t)   V(l,prot)  V(t)   V(l,prot)
______________________________________________________________________________
V prog
```

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	460		1076		704			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	704	
Potential Capacity	417	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	417	
Probability of Queue free St.	0.27	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		460
Potential Capacity		1065
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1065
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1076	
Potential Capacity	223	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.98	0.27
Movement Capacity	220	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1076	
Potential Capacity	223	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.98	0.27
Movement Capacity	220	
Results for Two-stage process:		
a		
y		
C t	220	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	64		304			
Movement Capacity (vph)	220		417			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	220		417			
Volume	64		304			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	16		64		304			
C(m) (vph)	1065		220		417			
v/c	0.02		0.29		0.73			
95% queue length	0.05		1.21		7.16			
Control Delay	8.4		28.0		35.8			
LOS	A		D		E			
Approach Delay				34.5				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.4	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

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_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       10/15/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2015
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      16     428                    424    480
Peak-Hour Factor, PHF       1.00   1.00                   1.00   1.00
Hourly Flow Rate, HFR       16     428                    424    480
Percent Heavy Vehicles      0      --     --              --     --
Median Type/Storage         Undivided            /
RT Channelized?                                               No
Lanes                          1   1                      1    1
Configuration                   L  T                      T   R
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      52            84
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       52            84
Percent Heavy Vehicles      6             23
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage              /                      /
Lanes                          1        1
Configuration                   L      R
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB        Westbound                Eastbound
Movement           1      4    |  7       8       9    |  10      11      12
Lane Config        L           |  L               R    |
______________________________________________________________________________
v (vph)            16             52              84
C(m) (vph)         761            206             578
v/c                0.02           0.25            0.15
95% queue length   0.06           1.00            0.51
Control Delay      9.8            28.4            12.3
LOS                 A              D               B
Approach Delay                            18.4
Approach LOS                               C
______________________________________________________________________________
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                    HCS+: Unsignalized Intersections Release 5.6




Phone:                                              Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       10/15/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2015
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                      16     428                  424    480
Peak-Hour Factor, PHF       1.00   1.00                 1.00   1.00
Peak-15 Minute Volume       4      107                  106    120
Hourly Flow Rate, HFR       16     428                  424    480
Percent Heavy Vehicles      0      --     --            --     --
Median Type/Storage         Undivided            /
RT Channelized?                                                No
Lanes                          1   1                    1    1
Configuration                   L  T                    T   R
Upstream Signal?                   No                   No
______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                      52            84
Peak Hour Factor, PHF       1.00          1.00
Peak-15 Minute Volume       13            21
Hourly Flow Rate, HFR       52            84
Percent Heavy Vehicles      6             23
Percent Grade (%)                  1                    0
Flared Approach:  Exists?/Storage              /                      /
RT Channelized?                           No
Lanes                          1        1
Configuration                   L      R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	0		6		23			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.1		6.7		6.5			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0		6		23			
t(f)	2.2		3.6		3.5			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	904		1124		428			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	428	
Potential Capacity	578	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	578	
Probability of Queue free St.	0.85	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		904
Potential Capacity		761
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		761
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1124	
Potential Capacity	210	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.84
Movement Capacity	206	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1124	
Potential Capacity	210	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.84
Movement Capacity	206	
Results for Two-stage process:		
a		
y		
C t	206	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	52		84			
Movement Capacity (vph)	206		578			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	206		578			
Volume	52		84			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	16		52		84			
C(m) (vph)	761		206		578			
v/c	0.02		0.25		0.15			
95% queue length	0.06		1.00		0.51			
Control Delay	9.8		28.4		12.3			
LOS	A		D		B			
Approach Delay				18.4				
Approach LOS				C				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	9.8	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS Analysis Results

For Site 1

Exit 92

Intersections on Southside & Northside of Interstate

Construction Traffic Condition

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              HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street:     I-94 EB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                             71     13       66     180
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              71     13       66     180
Percent Heavy Vehicles             --     --       14     --     --
Median Type/Storage         Undivided             /
RT Channelized?
Lanes                              1    0             0   1
Configuration                          TR              LT
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                                             303           205
Peak Hour Factor, PHF                              1.00          1.00
Hourly Flow Rate, HFR                              303           205
Percent Heavy Vehicles                             2             12
Percent Grade (%)                  0                      2
Flared Approach:  Exists?/Storage                /                      /
Lanes                                                 1        1
Configuration                                          L      R
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB          Westbound               Eastbound
Movement           1      4    |  7      8      9      |  10     11     12
Lane Config               LT   |                       |  L             R
______________________________________________________________________________
v (vph)                   66                              303           205
C(m) (vph)                1440                            561           829
v/c                       0.05                            0.54          0.25
95% queue length          0.14                            3.43          0.98
Control Delay             7.6                             18.9          10.8
LOS                        A                               C             B
Approach Delay                                                   15.6
Approach LOS                                                      C
______________________________________________________________________________
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              HCS+: Unsignalized Intersections Release 5.6




Phone:                                          Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street:     I-94 EB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                             71     13     66     180
Peak-Hour Factor, PHF              1.00   1.00   1.00   1.00
Peak-15 Minute Volume              18     3      16     45
Hourly Flow Rate, HFR              71     13     66     180
Percent Heavy Vehicles             --     --     14     --     --
Median Type/Storage         Undivided           /
RT Channelized?
Lanes                              1    0           0   1
Configuration                          TR            LT
Upstream Signal?                   No                   No
______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                                           303           205
Peak Hour Factor, PHF                            1.00          1.00
Peak-15 Minute Volume                            76            51
Hourly Flow Rate, HFR                            303           205
Percent Heavy Vehicles                           2             12
Percent Grade (%)                  0                    2
Flared Approach:  Exists?/Storage              /                      /
RT Channelized?                                                No
Lanes                                               1        1
Configuration                                        L      R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		180
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1				7.1		6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		14				2		12
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)		0.00				0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.2				6.8		6.5
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		14				2		12
t(f)		2.3				3.5		3.4

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		84				390		180
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		180
Potential Capacity		829
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		829
Probability of Queue free St.	1.00	0.75

Step 2: LT from Major St.	4	1
Conflicting Flows	84	
Potential Capacity	1440	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1440	
Probability of Queue free St.	0.95	1.00
Maj L-Shared Prob Q free St.	0.95	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		390
Potential Capacity		588
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.72	0.95
Movement Capacity		561

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.95	0.95
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		390
Potential Capacity		588
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.95	
Maj. L, Min T Adj. Imp Factor.	0.96	
Cap. Adj. factor due to Impeding mvmnt	0.72	0.95
Movement Capacity		561
Results for Two-stage process:		
a		
y		
C t		561

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				303		205
Movement Capacity (vph)				561		829
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				561		829
Volume				303		205
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		66				303		205
C(m) (vph)		1440				561		829
v/c		0.05				0.54		0.25
95% queue length		0.14				3.43		0.98
Control Delay		7.6				18.9		10.8
LOS		A				C		B
Approach Delay							15.6	
Approach LOS							C	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.95
v(il), Volume for stream 2 or 5		180
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.95
d(M,LT), Delay for stream 1 or 4		7.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.4

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: PM Peak Hour - Construction
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2020
Project ID: FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street: I-94 EB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		253	27	210	102	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		253	27	210	102	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				40		69
Peak Hour Factor, PHF				1.00		1.00
Hourly Flow Rate, HFR				40		69
Percent Heavy Vehicles				15		12
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
Lanes				1		1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		210				40		69
C(m) (vph)		1277				262		921
v/c		0.16				0.15		0.07
95% queue length		0.59				0.54		0.24
Control Delay		8.4				21.2		9.2
LOS		A				C		A
Approach Delay							13.6	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: PM Peak Hour - Construction
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2020
Project ID: FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street: I-94 EB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		253	27	210	102	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		63	7	52	26	
Hourly Flow Rate, HFR		253	27	210	102	
Percent Heavy Vehicles		--	--	3	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration		TR		LT		
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				40		69
Peak Hour Factor, PHF				1.00		1.00
Peak-15 Minute Volume				10		17
Hourly Flow Rate, HFR				40		69
Percent Heavy Vehicles				15		12
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage				/		/
RT Channelized?						No
Lanes				1		1
Configuration				L		R

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		102
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)		4.1				7.1		6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3				15		12
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)		0.00				0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.1				6.9		6.5
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3				15		12
t(f)		2.2				3.6		3.4

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x		280				788		102
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		102
Potential Capacity		921
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		921
Probability of Queue free St.	1.00	0.93

Step 2: LT from Major St.	4	1
Conflicting Flows	280	
Potential Capacity	1277	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1277	
Probability of Queue free St.	0.84	1.00
Maj L-Shared Prob Q free St.	0.83	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.83	0.83
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		788
Potential Capacity		314
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.83	
Maj. L, Min T Adj. Imp Factor.	0.87	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.84
Movement Capacity		262

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.83	0.83
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		788
Potential Capacity		314
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.83	
Maj. L, Min T Adj. Imp Factor.	0.87	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.84
Movement Capacity		262
Results for Two-stage process:		
a		
y		
C t		262

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				40		69
Movement Capacity (vph)				262		921
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				262		921
Volume				40		69
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		210				40		69
C(m) (vph)		1277				262		921
v/c		0.16				0.15		0.07
95% queue length		0.59				0.54		0.24
Control Delay		8.4				21.2		9.2
LOS		A				C		A
Approach Delay							13.6	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.84
v(il), Volume for stream 2 or 5		102
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.83
d(M,LT), Delay for stream 1 or 4		8.4
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.5

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2020
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS   Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	29	344			195	41
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	29	344			195	41
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	53		230			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	53		230			
Percent Heavy Vehicles	12		4			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	29		53		230			
C(m) (vph)	1275		427		694			
v/c	0.02		0.12		0.33			
95% queue length	0.07		0.42		1.48			
Control Delay	7.9		14.6		12.8			
LOS	A		B		B			
Approach Delay				13.1				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2020
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS   Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	29	344			195	41
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	7	86			49	10
Hourly Flow Rate, HFR	29	344			195	41
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	53		230			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	13		58			
Hourly Flow Rate, HFR	53		230			
Percent Heavy Vehicles	12		4			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage				/		/
RT Channelized?			No			
Lanes	1		1			
Configuration	L		R			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	344	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	12		12		4			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.5		6.2			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	12		12		4			
t(f)	2.3		3.6		3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	236		618		344			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	344	
Potential Capacity	694	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	694	
Probability of Queue free St.	0.67	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		236
Potential Capacity		1275
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1275
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	618	
Potential Capacity	437	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.65
Movement Capacity	427	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	618	
Potential Capacity	437	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.65
Movement Capacity	427	
Results for Two-stage process:		
a		
y		
C t	427	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	53		230			
Movement Capacity (vph)	427		694			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	427		694			
Volume	53		230			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	29		53		230			
C(m) (vph)	1275		427		694			
v/c	0.02		0.12		0.33			
95% queue length	0.07		0.42		1.48			
Control Delay	7.9		14.6		12.8			
LOS	A		B		B			
Approach Delay				13.1				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	344	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.97	
d(M,LT), Delay for stream 1 or 4	7.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.2	

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: PM Peak Hour - Construction
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2020
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	137	156			296	310
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	137	156			296	310
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	14		88			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	14		88			
Percent Heavy Vehicles	12		14			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	137		14		88			
C(m) (vph)	925		260		859			
v/c	0.15		0.05		0.10			
95% queue length	0.52		0.17		0.34			
Control Delay	9.6		19.6		9.7			
LOS	A		C		A			
Approach Delay				11.0				
Approach LOS				B				

```
                    HCS+: Unsignalized Intersections Release 5.6



Phone:                                        Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Construction
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street:     I-94 WB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
_____________________________________________________________________________
Volume                     137    156                  296    310
Peak-Hour Factor, PHF      1.00   1.00                 1.00   1.00
Peak-15 Minute Volume      34     39                   74     78
Hourly Flow Rate, HFR      137    156                  296    310
Percent Heavy Vehicles     12     --     --            --     --
Median Type/Storage         Undivided             /
RT Channelized?
Lanes                         0   1                    1    0
Configuration                   LT                         TR
Upstream Signal?                   No                   No
_____________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
_____________________________________________________________________________
Volume                     14            88
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      4             22
Hourly Flow Rate, HFR      14            88
Percent Heavy Vehicles     12            14
Percent Grade (%)                 0                    2
Flared Approach:  Exists?/Storage               /                      /
RT Channelized?                          No
Lanes                         1        1
Configuration                   L      R
_____________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
_____________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

```
Lane Width (ft)              12.0   12.0   12.0   12.0
Walking Speed (ft/sec)       4.0    4.0    4.0    4.0
Percent Blockage             0      0      0      0
_____________________________________________________________________________

____________________________Upstream Signal Data______________________________
                 Prog.    Sat   Arrival   Green  Cycle   Prog.   Distance
                 Flow     Flow   Type     Time   Length  Speed   to Signal
                 vph      vph             sec     sec     mph      feet
_____________________________________________________________________________
S2  Left-Turn
    Through
S5  Left-Turn
    Through
_____________________________________________________________________________

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles
_____________________________________________________________________________
                                           Movement 2     Movement 5
_____________________________________________________________________________
Shared ln volume, major th vehicles:         156
Shared ln volume, major rt vehicles:         0
Sat flow rate, major th vehicles:            1700
Sat flow rate, major rt vehicles:            1700
Number of major street through lanes:        1
_____________________________________________________________________________

Worksheet 4-Critical Gap and Follow-up Time Calculation
_____________________________________________________________________________
Critical Gap Calculation
Movement             1      4      7      8      9      10     11     12
                     L      L      L      T      R      L      T      R
_____________________________________________________________________________
t(c,base)        4.1           7.1           6.2
t(c,hv)          1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00
P(hv)            12            12            14
t(c,g)                         0.20   0.20   0.10   0.20   0.20   0.10
Percent Grade                  0.00   0.00   0.00   2.00   2.00   2.00
t(3,lt)          0.00          0.70          0.00
t(c,T):  1-stage 0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00
         2-stage 0.00   0.00   1.00   1.00   0.00   1.00   1.00   0.00
t(c)     1-stage 4.2           6.5           6.3
         2-stage
_____________________________________________________________________________
Follow-Up Time Calculations
Movement             1      4      7      8      9      10     11     12
                     L      L      L      T      R      L      T      R
_____________________________________________________________________________
t(f,base)        2.20          3.50          3.30
t(f,HV)          0.90   0.90   0.90   0.90   0.90   0.90   0.90   0.90
P(HV)            12            12            14
t(f)             2.3           3.6           3.4
_____________________________________________________________________________

Worksheet 5-Effect of Upstream Signals
_____________________________________________________________________________
Computation 1-Queue Clearance Time at Upstream Signal
                                            Movement 2        Movement 5
                                         V(t)   V(l,prot)  V(t)   V(l,prot)
_____________________________________________________________________________
V prog
```

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	606		881		156			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	156	
Potential Capacity	859	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	859	
Probability of Queue free St.	0.90	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		606
Potential Capacity		925
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		925
Probability of Queue free St.	1.00	0.85
Maj L-Shared Prob Q free St.		0.84

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	881	
Potential Capacity	305	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.84
Maj. L, Min T Adj. Imp Factor.		0.87
Cap. Adj. factor due to Impeding mvmnt	0.85	0.79
Movement Capacity	260	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	881	
Potential Capacity	305	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.84
Maj. L, Min T Adj. Imp Factor.		0.87
Cap. Adj. factor due to Impeding mvmnt	0.85	0.79
Movement Capacity	260	
Results for Two-stage process:		
a		
y		
C t	260	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	14		88			
Movement Capacity (vph)	260		859			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	260		859			
Volume	14		88			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	137		14		88			
C(m) (vph)	925		260		859			
v/c	0.15		0.05		0.10			
95% queue length	0.52		0.17		0.34			
Control Delay	9.6		19.6		9.7			
LOS	A		C		A			
Approach Delay				11.0				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.85	1.00
v(il), Volume for stream 2 or 5	156	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.84	
d(M,LT), Delay for stream 1 or 4	9.6	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.6	

HCS Analysis Results

For Site 1

Exit 92

Intersections on Southside & Northside of Interstate

Operation Traffic Condition

```
                  HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY__________________________

Analyst:               Kevin Harder
Agency/Co.:            B&V
Date Performed:        3/4/2016
Analysis Time Period: AM Peak Hour - Operation
Intersection:          I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:         2022
Project ID:  FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street:      I-94 EB Off Ramp
North/South Street:    40th St
Intersection Orientation: NS                Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach        Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
_____________________________________________________________________________
Volume                             65     13       106    184
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              65     13       106    184
Percent Heavy Vehicles             --     --       8      --     --
Median Type/Storage         Undivided             /
RT Channelized?
Lanes                              1    0             0   1
Configuration                          TR             LT
Upstream Signal?                   No                     No
_____________________________________________________________________________
Minor Street:  Approach        Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
_____________________________________________________________________________
Volume                                             157           208
Peak Hour Factor, PHF                              1.00          1.00
Hourly Flow Rate, HFR                              157           208
Percent Heavy Vehicles                             1             12
Percent Grade (%)                  0                      2
Flared Approach:  Exists?/Storage                /                    /
Lanes                                                 1        1
Configuration                                          L      R
_____________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB       Westbound           Eastbound
Movement           1      4   |  7      8      9    |  10     11     12
Lane Config               LT  |                     |  L             R
_____________________________________________________________________________
v (vph)                   106                          157           208
C(m) (vph)                1483                         489           825
v/c                       0.07                         0.32          0.25
95% queue length          0.23                         1.41          1.01
Control Delay             7.6                          15.8          10.8
LOS                        A                            C             B
Approach Delay                                               13.0
Approach LOS                                                  B
_____________________________________________________________________________
```

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Operation
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2022
Project ID: FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street: I-94 EB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		65	13	106	184	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		16	3	26	46	
Hourly Flow Rate, HFR		65	13	106	184	
Percent Heavy Vehicles		--	--	8	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				157		208
Peak Hour Factor, PHF				1.00		1.00
Peak-15 Minute Volume				39		52
Hourly Flow Rate, HFR				157		208
Percent Heavy Vehicles				1		12
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage				/		/
RT Channelized?						No
Lanes				1		1
Configuration				L		R

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		184
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)		4.1				7.1		6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		8				1		12
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)		0.00				0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.2				6.8		6.5
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		8				1		12
t(f)		2.3				3.5		3.4

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x		78				468		184
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		184
Potential Capacity		825
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		825
Probability of Queue free St.	1.00	0.75

Step 2: LT from Major St.	4	1
Conflicting Flows	78	
Potential Capacity	1483	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1483	
Probability of Queue free St.	0.93	1.00
Maj L-Shared Prob Q free St.	0.92	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		468
Potential Capacity		527
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	
Maj. L, Min T Adj. Imp Factor.	0.94	
Cap. Adj. factor due to Impeding mvmnt	0.70	0.93
Movement Capacity		489

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.92	0.92
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		468
Potential Capacity		527
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.92	
Maj. L, Min T Adj. Imp Factor.	0.94	
Cap. Adj. factor due to Impeding mvmnt	0.70	0.93
Movement Capacity		489
Results for Two-stage process:		
a		
y		
C t		489

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				157		208
Movement Capacity (vph)				489		825
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				489		825
Volume				157		208
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		106				157		208
C(m) (vph)		1483				489		825
v/c		0.07				0.32		0.25
95% queue length		0.23				1.41		1.01
Control Delay		7.6				15.8		10.8
LOS		A				C		B
Approach Delay							13.0	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.93
v(il), Volume for stream 2 or 5		184
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.92
d(M,LT), Delay for stream 1 or 4		7.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.6

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_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operation
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street:     I-94 EB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                             258    27       189    96
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              258    27       189    96
Percent Heavy Vehicles             --     --       3      --     --
Median Type/Storage         Undivided             /
RT Channelized?
Lanes                              1    0            0   1
Configuration                          TR             LT
Upstream Signal?                   No                     No

_______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                                             63            70
Peak Hour Factor, PHF                              1.00          1.00
Hourly Flow Rate, HFR                              63            70
Percent Heavy Vehicles                             5             12
Percent Grade (%)                  0                      2
Flared Approach:  Exists?/Storage                /                      /
Lanes                                                 1        1
Configuration                                          L      R
_______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB        Westbound              Eastbound
Movement           1      4    |  7      8      9     |  10     11     12
Lane Config               LT   |                      |  L             R
_______________________________________________________________________________
v (vph)                   189                            63            70
C(m) (vph)                1271                           295           929
v/c                       0.15                           0.21          0.08
95% queue length          0.52                           0.81          0.24
Control Delay             8.3                            20.5          9.2
LOS                        A                              C             A
Approach Delay                                                  14.6
Approach LOS                                                     B
_______________________________________________________________________________
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               HCS+: Unsignalized Intersections Release 5.6




Phone:                                        Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operation
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street:     I-94 EB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                             258    27     189    96
Peak-Hour Factor, PHF              1.00   1.00   1.00   1.00
Peak-15 Minute Volume              64     7      47     24
Hourly Flow Rate, HFR              258    27     189    96
Percent Heavy Vehicles             --     --     3      --     --
Median Type/Storage         Undivided             /
RT Channelized?
Lanes                              1    0           0   1
Configuration                          TR            LT
Upstream Signal?                   No                    No
_______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                                           63            70
Peak Hour Factor, PHF                            1.00          1.00
Peak-15 Minute Volume                            16            18
Hourly Flow Rate, HFR                            63            70
Percent Heavy Vehicles                           5             12
Percent Grade (%)                  0                    2
Flared Approach:  Exists?/Storage                /                      /
RT Channelized?                                                No
Lanes                                               1        1
Configuration                                        L      R
_______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
_______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		96
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1				7.1		6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		3				5		12
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)		0.00				0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.1				6.8		6.5
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		3				5		12
t(f)		2.2				3.5		3.4

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		285				746		96
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		96
Potential Capacity		929
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		929
Probability of Queue free St.	1.00	0.92

Step 2: LT from Major St.	4	1
Conflicting Flows	285	
Potential Capacity	1271	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1271	
Probability of Queue free St.	0.85	1.00
Maj L-Shared Prob Q free St.	0.84	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		746
Potential Capacity		347
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.84	
Maj. L, Min T Adj. Imp Factor.	0.88	
Cap. Adj. factor due to Impeding mvmnt	0.81	0.85
Movement Capacity		295

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.84	0.84
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		746
Potential Capacity		347
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.84	
Maj. L, Min T Adj. Imp Factor.	0.88	
Cap. Adj. factor due to Impeding mvmnt	0.81	0.85
Movement Capacity		295
Results for Two-stage process:		
a		
y		
C t		295

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				63		70
Movement Capacity (vph)				295		929
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				295		929
Volume				63		70
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		189				63		70
C(m) (vph)		1271				295		929
v/c		0.15				0.21		0.08
95% queue length		0.52				0.81		0.24
Control Delay		8.3				20.5		9.2
LOS		A				C		A
Approach Delay							14.6	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.85
v(il), Volume for stream 2 or 5		96
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.84
d(M,LT), Delay for stream 1 or 4		8.3
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		1.3

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Operations
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2022
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	29	191			237	64
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	29	191			237	64
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	54		210			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	54		210			
Percent Heavy Vehicles	12		4			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	29		54		210			
C(m) (vph)	1205		489		846			
v/c	0.02		0.11		0.25			
95% queue length	0.07		0.37		0.99			
Control Delay	8.1		13.3		10.7			
LOS	A		B		B			
Approach Delay				11.2				
Approach LOS				B				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Operations
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2022
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	29	191			237	64
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	7	48			59	16
Hourly Flow Rate, HFR	29	191			237	64
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	54		210			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	14		52			
Hourly Flow Rate, HFR	54		210			
Percent Heavy Vehicles	12		4			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
RT Channelized?			No			
Lanes	1		1			
Configuration	L		R			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	191	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	12		12		4			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.5		6.2			
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	12		12		4			
t(f)	2.3		3.6		3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	301		518		191			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	191	
Potential Capacity	846	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	846	
Probability of Queue free St.	0.75	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		301
Potential Capacity		1205
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1205
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.97

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	518	
Potential Capacity	501	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.74
Movement Capacity	489	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	518	
Potential Capacity	501	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.74
Movement Capacity	489	
Results for Two-stage process:		
a		
y		
C t	489	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	54		210			
Movement Capacity (vph)	489		846			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	489		846			
Volume	54		210			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	29		54		210			
C(m) (vph)	1205		489		846			
v/c	0.02		0.11		0.25			
95% queue length	0.07		0.37		0.99			
Control Delay	8.1		13.3		10.7			
LOS	A		B		B			
Approach Delay				11.2				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	191	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.97	
d(M,LT), Delay for stream 1 or 4	8.1	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.2	

```
                HCS+: Unsignalized Intersections Release 5.6

______________________TWO-WAY STOP CONTROL SUMMARY__________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operations
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street:     I-94 WB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                Study period (hrs):  1.00

_____________________Vehicle Volumes and Adjustments________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
____________________________________________________________________________
Volume                      139    183                    269    157
Peak-Hour Factor, PHF       1.00   1.00                   1.00   1.00
Hourly Flow Rate, HFR       139    183                    269    157
Percent Heavy Vehicles      12     --     --              --     --
Median Type/Storage         Undivided            /
RT Channelized?
Lanes                          0   1                      1    0
Configuration                   LT                           TR
Upstream Signal?                   No                     No
____________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
____________________________________________________________________________
Volume                      14            128
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       14            128
Percent Heavy Vehicles      12            9
Percent Grade (%)                  0                      2
Flared Approach:  Exists?/Storage               /                      /
Lanes                          1        1
Configuration                   L      R
____________________________________________________________________________

__________________Delay, Queue Length, and Level of Service_________________
Approach           NB     SB          Westbound             Eastbound
Movement           1      4     |  7      8      9     |  10     11     12
Lane Config        LT           |  L             R     |
____________________________________________________________________________
v (vph)            139             14            128
C(m) (vph)         1082            293           842
v/c                0.13            0.05          0.15
95% queue length   0.44            0.15          0.54
Control Delay      8.8             17.9          10.0+
LOS                 A               C             B
Approach Delay                            10.8
Approach LOS                               B
____________________________________________________________________________
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                HCS+: Unsignalized Intersections Release 5.6



Phone:                                       Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operations
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street:     I-94 WB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
____________________________________________________________________________
Volume                     139    183                  269    157
Peak-Hour Factor, PHF      1.00   1.00                 1.00   1.00
Peak-15 Minute Volume      35     46                   67     39
Hourly Flow Rate, HFR      139    183                  269    157
Percent Heavy Vehicles     12     --     --            --     --
Median Type/Storage         Undivided           /
RT Channelized?
Lanes                         0   1                    1    0
Configuration                  LT                          TR
Upstream Signal?                  No                   No
____________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
____________________________________________________________________________
Volume                     14            128
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      4             32
Hourly Flow Rate, HFR      14            128
Percent Heavy Vehicles     12            9
Percent Grade (%)                 0                    2
Flared Approach:  Exists?/Storage               /                      /
RT Channelized?                          No
Lanes                         1        1
Configuration                  L      R
____________________________________________________________________________

______________________Pedestrian Volumes and Adjustments_____________________
Movements                    13     14     15     16
____________________________________________________________________________
Flow (ped/hr)                0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	183	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1		7.1		6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		12		12		9			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)		0.00		0.70		0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2		6.5		6.3			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	12		12		9			
t(f)	2.3		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	426		809		183			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	183	
Potential Capacity	842	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	842	
Probability of Queue free St.	0.85	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		426
Potential Capacity		1082
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1082
Probability of Queue free St.	1.00	0.87
Maj L-Shared Prob Q free St.		0.86

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	809	
Potential Capacity	336	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.86
Maj. L, Min T Adj. Imp Factor.		0.89
Cap. Adj. factor due to Impeding mvmnt	0.87	0.75
Movement Capacity	293	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	809	
Potential Capacity	336	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.86
Maj. L, Min T Adj. Imp Factor.		0.89
Cap. Adj. factor due to Impeding mvmnt	0.87	0.75
Movement Capacity	293	
Results for Two-stage process:		
a		
y		
C t	293	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	14		128			
Movement Capacity (vph)	293		842			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	293		842			
Volume	14		128			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	139		14		128			
C(m) (vph)	1082		293		842			
v/c	0.13		0.05		0.15			
95% queue length	0.44		0.15		0.54			
Control Delay	8.8		17.9		10.0+			
LOS	A		C		B			
Approach Delay				10.8				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.87	1.00
v(il), Volume for stream 2 or 5	183	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.86	
d(M,LT), Delay for stream 1 or 4	8.8	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	1.3	

HCS Analysis Results

For FCTC Site 2

Exit 88

Intersections on Southside & Northside of Interstate

Existing Traffic Condition

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/12/2015
Analysis Time Period:
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street: I-94 EB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		56	13	44	173	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		56	13	44	173	
Percent Heavy Vehicles		--	--	12	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR	LT		
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				0		197
Peak Hour Factor, PHF				1.00		1.00
Hourly Flow Rate, HFR				0		197
Percent Heavy Vehicles				12		12
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
Lanes				1		1
Configuration				L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		44				0		197
C(m) (vph)		1471				609		837
v/c		0.03				0.00		0.24
95% queue length		0.09				0.00		0.92
Control Delay		7.5				10.9		10.6
LOS		A				B		B
Approach Delay							10.6	
Approach LOS							B	

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/12/2015
Analysis Time Period:
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street: I-94 EB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		56	13	44	173	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Peak-15 Minute Volume		14	3	11	43	
Hourly Flow Rate, HFR		56	13	44	173	
Percent Heavy Vehicles		--	--	12	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	0	1	
Configuration			TR		LT	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume				0		197
Peak Hour Factor, PHF				1.00		1.00
Peak-15 Minute Volume				0		49
Hourly Flow Rate, HFR				0		197
Percent Heavy Vehicles				12		12
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage				/		/
RT Channelized?						No
Lanes				1		1
Configuration				L		R

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		173
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)		4.1				7.1		6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		12				12		12
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)		0.00				0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.2				6.9		6.5
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		12				12		12
t(f)		2.3				3.6		3.4

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		69				323		173
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7 Stage1	7 Stage2	8 Stage1	8 Stage2	10 Stage1	10 Stage2	11 Stage1	11 Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		173
Potential Capacity		837
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		837
Probability of Queue free St.	1.00	0.76

Step 2: LT from Major St.	4	1
Conflicting Flows	69	
Potential Capacity	1471	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1471	
Probability of Queue free St.	0.97	1.00
Maj L-Shared Prob Q free St.	0.97	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		323
Potential Capacity		628
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.75	0.97
Movement Capacity		609

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		323
Potential Capacity		628
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.75	0.97
Movement Capacity		609
Results for Two-stage process:		
a		
y		
C t		609

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				0		197
Movement Capacity (vph)				609		837
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep				609		837
Volume				0		197
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		44				0		197
C(m) (vph)		1471				609		837
v/c		0.03				0.00		0.24
95% queue length		0.09				0.00		0.92
Control Delay		7.5				10.9		10.6
LOS		A				B		B
Approach Delay							10.6	
Approach LOS							B	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.97
v(il), Volume for stream 2 or 5		173
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.97
d(M,LT), Delay for stream 1 or 4		7.5
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.3

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              HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       10/12/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2015
Project ID:  FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street:     I-94 EB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                 Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound             Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                             243    26       24
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              243    26       24     173
Percent Heavy Vehicles             --     --       12     --     --
Median Type/Storage         Undivided             /
RT Channelized?
Lanes                              1    0             0   1
Configuration                          TR              LT
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound              Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                                             5             67
Peak Hour Factor, PHF                              1.00          1.00
Hourly Flow Rate, HFR                              5             67
Percent Heavy Vehicles                             12            12
Percent Grade (%)                  0                      2
Flared Approach:  Exists?/Storage               /                     /
Lanes                                                 1        1
Configuration                                          L      R
______________________________________________________________________________

_________________Delay, Queue Length, and Level of Service___________________
Approach           NB     SB        Westbound              Eastbound
Movement           1      4    |  7      8      9     |  10      11     12
Lane Config               LT   |                      |  L              R
______________________________________________________________________________
v (vph)                   24                             5              67
C(m) (vph)                1239                           492            837
v/c                       0.02                           0.01           0.08
95% queue length          0.06                           0.03           0.26
Control Delay             8.0                            12.4           9.7
LOS                        A                              B              A
Approach Delay                                                  9.9
Approach LOS                                                     A
______________________________________________________________________________
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              HCS+: Unsignalized Intersections Release 5.6

Phone:                                          Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       10/12/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection:         I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2015
Project ID:  FCTC I-94 & 40th St Interchange S. Side, Exit 88
East/West Street:     I-94 EB Off Ramp
North/South Street:   40th St
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                             243    26     24
Peak-Hour Factor, PHF              1.00   1.00   1.00   1.00
Peak-15 Minute Volume              61     6      6      43
Hourly Flow Rate, HFR              243    26     24     173
Percent Heavy Vehicles             --     --     12     --     --
Median Type/Storage         Undivided           /
RT Channelized?
Lanes                              1    0           0   1
Configuration                          TR            LT
Upstream Signal?                   No                   No
______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                                           5             67
Peak Hour Factor, PHF                            1.00          1.00
Peak-15 Minute Volume                            1             17
Hourly Flow Rate, HFR                            5             67
Percent Heavy Vehicles                           12            12
Percent Grade (%)                  0                    2
Flared Approach:  Exists?/Storage               /                     /
RT Channelized?                                                No
Lanes                                               1        1
Configuration                                        L      R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		173
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1				7.1		6.2
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		12				12		12
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)		0.00				0.70		0.00
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.2				6.9		6.5
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20				3.50		3.30
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		12				12		12
t(f)		2.3				3.6		3.4

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		269				477		173
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s						1500		
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows		173
Potential Capacity		837
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		837
Probability of Queue free St.	1.00	0.92

Step 2: LT from Major St.	4	1
Conflicting Flows	269	
Potential Capacity	1239	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1239	
Probability of Queue free St.	0.98	1.00
Maj L-Shared Prob Q free St.	0.98	

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows		477
Potential Capacity		502
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	
Maj. L, Min T Adj. Imp Factor.	0.98	
Cap. Adj. factor due to Impeding mvmnt	0.90	0.98
Movement Capacity		492

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		477
Potential Capacity		502
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	
Maj. L, Min T Adj. Imp Factor.	0.98	
Cap. Adj. factor due to Impeding mvmnt	0.90	0.98
Movement Capacity		492
Results for Two-stage process:		
a		
y		
C t		492

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)				5		67
Movement Capacity (vph)				492		837
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep				492		837
Volume				5		67
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT				L		R
v (vph)		24				5		67
C(m) (vph)		1239				492		837
v/c		0.02				0.01		0.08
95% queue length		0.06				0.03		0.26
Control Delay		8.0				12.4		9.7
LOS		A				B		A
Approach Delay							9.9	
Approach LOS							A	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5		173
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.98
d(M,LT), Delay for stream 1 or 4		8.0
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.2

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/12/2015
Analysis Time Period: AM Peak Hour - Existing
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	28	27			166	6
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	28	27			166	6
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT					TR
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	50		44			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	50		44			
Percent Heavy Vehicles	12		12			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	28		50		44			
C(m) (vph)	1347		700		1020			
v/c	0.02		0.07		0.04			
95% queue length	0.06		0.23		0.14			
Control Delay	7.7		10.5		8.7			
LOS	A		B		A			
Approach Delay				9.7				
Approach LOS				A				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/12/2015
Analysis Time Period: AM Peak Hour - Existing
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	28	27			166	6
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	7	7			42	2
Hourly Flow Rate, HFR	28	27			166	6
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	50		44			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	12		11			
Hourly Flow Rate, HFR	50		44			
Percent Heavy Vehicles	12		12			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage				/		/
RT Channelized?			No			
Lanes	1		1			
Configuration	L		R			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	27	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	12		12		12			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.5		6.3			
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	12		12		12			
t(f)	2.3		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	172		252		27			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	27	
Potential Capacity	1020	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1020	
Probability of Queue free St.	0.96	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		172
Potential Capacity		1347
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1347
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.98

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	252	
Potential Capacity	715	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.94
Movement Capacity	700	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	252	
Potential Capacity	715	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.94
Movement Capacity	700	
Results for Two-stage process:		
a		
y		
C t	700	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	50		44			
Movement Capacity (vph)	700		1020			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	700		1020			
Volume	50		44			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	28		50		44			
C(m) (vph)	1347		700		1020			
v/c	0.02		0.07		0.04			
95% queue length	0.06		0.23		0.14			
Control Delay	7.7		10.5		8.7			
LOS	A		B		A			
Approach Delay				9.7				
Approach LOS				A				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5	27	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.98	
d(M,LT), Delay for stream 1 or 4	7.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.2	

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/12/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	132	116			95	7
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	132	116			95	7
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	14		65			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	14		65			
Percent Heavy Vehicles	12		12			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	132		14		65			
C(m) (vph)	1430		479		910			
v/c	0.09		0.03		0.07			
95% queue length	0.30		0.09		0.23			
Control Delay	7.8		12.7		9.3			
LOS	A		B		A			
Approach Delay				9.9				
Approach LOS				A				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 10/12/2015
Analysis Time Period: PM Peak Hour - Existing
Intersection: I-94 & 40th S. Side, Exit 88
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2015
Project ID: FCTC I-94 & 40th St Interchange N. Side, Exit 88
East/West Street: I-94 WB Off Ramp
North/South Street: 40th St
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	132	116			95	7
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Peak-15 Minute Volume	33	29			24	2
Hourly Flow Rate, HFR	132	116			95	7
Percent Heavy Vehicles	12	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes	0	1			1	0
Configuration	LT				TR	
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	14		65			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	4		16			
Hourly Flow Rate, HFR	14		65			
Percent Heavy Vehicles	12		12			
Percent Grade (%)		0			2	
Flared Approach: Exists?/Storage			/			/
RT Channelized?			No			
Lanes	1		1			
Configuration	L		R			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	116	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	12		12		12			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			0.00	0.00	0.00	2.00	2.00	2.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.5		6.3			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	12		12		12			
t(f)	2.3		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	102		478		116			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	116	
Potential Capacity	910	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	910	
Probability of Queue free St.	0.93	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		102
Potential Capacity		1430
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1430
Probability of Queue free St.	1.00	0.91
Maj L-Shared Prob Q free St.		0.90

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	478	
Potential Capacity	528	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.91	0.86
Movement Capacity	479	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.90	0.90
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	478	
Potential Capacity	528	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.90
Maj. L, Min T Adj. Imp Factor.		0.92
Cap. Adj. factor due to Impeding mvmnt	0.91	0.86
Movement Capacity	479	
Results for Two-stage process:		
a		
y		
C t	479	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	14		65			
Movement Capacity (vph)	479		910			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	479		910			
Volume	14		65			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT		L		R			
v (vph)	132		14		65			
C(m) (vph)	1430		479		910			
v/c	0.09		0.03		0.07			
95% queue length	0.30		0.09		0.23			
Control Delay	7.8		12.7		9.3			
LOS	A		B		A			
Approach Delay				9.9				
Approach LOS				A				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.91	1.00
v(il), Volume for stream 2 or 5	116	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.90	
d(M,LT), Delay for stream 1 or 4	7.8	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.8	

HCS Analysis Results

For Site 2

Exit 88

Intersections on Southside & Northside of Interstate

Construction Traffic Condition

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                  HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection:         I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:     I-94 EB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                             247    54       132    158
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              247    54       132    158
Percent Heavy Vehicles             --     --       28     --     --
Median Type/Storage         Undivided             /
RT Channelized?                          No
Lanes                              1    1            1    1
Configuration                      T   R              L  T
Upstream Signal?                   No                     No
_______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                      4             854
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       4             854
Percent Heavy Vehicles      50            3
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage               /                     /
Lanes                           1        1
Configuration                    L      R
_______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach             NB     SB        Westbound             Eastbound
Movement             1      4   |  7      8       9    |  10     11     12
Lane Config                 L   |  L              R    |
_______________________________________________________________________________
v (vph)                     132    4              854
C(m) (vph)                  1126   304            784
v/c                         0.12   0.01           1.09
95% queue length            0.40   0.04           57.34
Control Delay               8.6    17.0           214.3
LOS                          A      C              F
Approach Delay                           213.4
Approach LOS                              F
_______________________________________________________________________________
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                  HCS+: Unsignalized Intersections Release 5.6



Phone:                                              Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection:         I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:     I-94 EB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                             247    54     132    158
Peak-Hour Factor, PHF              1.00   1.00   1.00   1.00
Peak-15 Minute Volume              62     14     33     40
Hourly Flow Rate, HFR              247    54     132    158
Percent Heavy Vehicles             --     --     28     --     --
Median Type/Storage         Undivided            /
RT Channelized?                          No
Lanes                              1    1           1    1
Configuration                      T   R             L  T
Upstream Signal?                   No                    No
_______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                     4             854
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      1             214
Hourly Flow Rate, HFR      4             854
Percent Heavy Vehicles     50            3
Percent Grade (%)                  1                     0
Flared Approach:  Exists?/Storage               /                      /
RT Channelized?                          No
Lanes                          1        1
Configuration                   L      R
_______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
_______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		28	50		3			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.4	7.1		6.3			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		28	50		3			
t(f)		2.5	4.0		3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		301	669		247			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	247	
Potential Capacity	784	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	784	
Probability of Queue free St.	0.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	301	
Potential Capacity	1126	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1126	
Probability of Queue free St.	0.88	1.00
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	669	
Potential Capacity	344	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.88
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.88	0.00
Movement Capacity	304	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.88	0.88
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	669	
Potential Capacity	344	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.88
Maj. L, Min T Adj. Imp Factor.		0.91
Cap. Adj. factor due to Impeding mvmnt	0.88	0.00
Movement Capacity	304	
Results for Two-stage process:		
a		
y		
C t	304	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4		854			
Movement Capacity (vph)	304		784			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	304		784			
Volume	4		854			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		R			
v (vph)		132	4		854			
C(m) (vph)		1126	304		784			
v/c		0.12	0.01		1.09			
95% queue length		0.40	0.04		57.34			
Control Delay		8.6	17.0		214.3			
LOS		A	C		F			
Approach Delay				213.4				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.88
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		8.6
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4//2016
Analysis Time Period: PM Peak Hour - Construction
Intersection: I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2020
Project ID: FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street: I-94 EB Off Ramp
North/South Street: I-94BL
Intersection Orientation: NS   Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		166	75	380	259	
Peak-Hour Factor, PHF		1.00	1.00	1.00	1.00	
Hourly Flow Rate, HFR		166	75	380	259	
Percent Heavy Vehicles		--	--	7	--	--
Median Type/Storage	Undivided			/		
RT Channelized?			No			
Lanes		1	1	1	1	
Configuration		T	R	L	T	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	4		283			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	4		283			
Percent Heavy Vehicles	0		7			
Percent Grade (%)		1			0	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		R			
v (vph)		380	4		283			
C(m) (vph)		1297	139		861			
v/c		0.29	0.03		0.33			
95% queue length		1.24	0.09		1.46			
Control Delay		8.9	31.7		11.2			
LOS		A	D		B			
Approach Delay				11.5				
Approach LOS				B				

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                 HCS+: Unsignalized Intersections Release 5.6




Phone:                                      Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4//2016
Analysis Time Period: PM Peak Hour - Construction
Intersection:         I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:     I-94 EB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                             166    75     380    259
Peak-Hour Factor, PHF              1.00   1.00   1.00   1.00
Peak-15 Minute Volume              42     19     95     65
Hourly Flow Rate, HFR              166    75     380    259
Percent Heavy Vehicles             --     --     7      --     --
Median Type/Storage         Undivided               /
RT Channelized?                           No
Lanes                              1    1             1   1
Configuration                      T   R               L  T
Upstream Signal?                   No                   No
______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     4             283
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      1             71
Hourly Flow Rate, HFR      4             283
Percent Heavy Vehicles     0             7
Percent Grade (%)                 1                    0
Flared Approach:  Exists?/Storage               /                     /
RT Channelized?                           No
Lanes                         1        1
Configuration                  L      R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                    13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                0      0      0      0
```

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Lane Width (ft)              12.0   12.0   12.0   12.0
Walking Speed (ft/sec)       4.0    4.0    4.0    4.0
Percent Blockage             0      0      0      0
______________________________________________________________________________

_____________________________Upstream Signal Data_____________________________
                 Prog.    Sat   Arrival   Green  Cycle   Prog.   Distance
                 Flow     Flow   Type     Time   Length  Speed   to Signal
                 vph      vph             sec     sec     mph      feet
______________________________________________________________________________
S2  Left-Turn
    Through
S5  Left-Turn
    Through
______________________________________________________________________________

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles
______________________________________________________________________________
                                           Movement 2     Movement 5
______________________________________________________________________________
Shared ln volume, major th vehicles:
Shared ln volume, major rt vehicles:
Sat flow rate, major th vehicles:
Sat flow rate, major rt vehicles:
Number of major street through lanes:
______________________________________________________________________________

Worksheet 4-Critical Gap and Follow-up Time Calculation
______________________________________________________________________________
Critical Gap Calculation
Movement           1      4      7      8      9      10     11     12
                   L      L      L      T      R      L      T      R
______________________________________________________________________________
t(c,base)                 4.1    7.1           6.2
t(c,hv)            1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00
P(hv)                     7      0             7
t(c,g)                           0.20   0.20   0.10   0.20   0.20   0.10
Percent Grade                    1.00   1.00   1.00   0.00   0.00   0.00
t(3,lt)                   0.00   0.70          0.00
t(c,T):  1-stage   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00
         2-stage   0.00   0.00   1.00   1.00   0.00   1.00   1.00   0.00
t(c)     1-stage          4.2    6.6           6.4
         2-stage
______________________________________________________________________________
Follow-Up Time Calculations
Movement           1      4      7      8      9      10     11     12
                   L      L      L      T      R      L      T      R
______________________________________________________________________________
t(f,base)                 2.20   3.50          3.30
t(f,HV)            0.90   0.90   0.90   0.90   0.90   0.90   0.90   0.90
P(HV)                     7      0             7
t(f)                      2.3    3.5           3.4
______________________________________________________________________________

Worksheet 5-Effect of Upstream Signals
______________________________________________________________________________
Computation 1-Queue Clearance Time at Upstream Signal
                                            Movement 2        Movement 5
                                         V(t)   V(l,prot)  V(t)   V(l,prot)
______________________________________________________________________________
V prog
```

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x		241	1185		166			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	166	
Potential Capacity	861	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	861	
Probability of Queue free St.	0.67	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	241	
Potential Capacity	1297	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1297	
Probability of Queue free St.	0.71	1.00
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.71	0.71
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1185	
Potential Capacity	197	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.71
Maj. L, Min T Adj. Imp Factor.		0.77
Cap. Adj. factor due to Impeding mvmnt	0.71	0.52
Movement Capacity	139	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.71	0.71
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10

Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1185	
Potential Capacity	197	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.71
Maj. L, Min T Adj. Imp Factor.		0.77
Cap. Adj. factor due to Impeding mvmnt	0.71	0.52
Movement Capacity	139	

Results for Two-stage process:		
a		
y		
C t	139	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4		283			
Movement Capacity (vph)	139		861			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	139		861			
Volume	4		283			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		R			
v (vph)		380	4		283			
C(m) (vph)		1297	139		861			
v/c		0.29	0.03		0.33			
95% queue length		1.24	0.09		1.46			
Control Delay		8.9	31.7		11.2			
LOS		A	D		B			
Approach Delay				11.5				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.71
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		8.9
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

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               HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/2/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                      17     1072                   244    283
Peak-Hour Factor, PHF       1.00   1.00                   1.00   1.00
Hourly Flow Rate, HFR       17     1072                   244    283
Percent Heavy Vehicles      10     --     --              --     --
Median Type/Storage         Undivided            /
RT Channelized?                                              No
Lanes                          1   1                      1    1
Configuration                   L  T                      T   R
Upstream Signal?                   No                     No
_______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
_______________________________________________________________________________
Volume                      66            414
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       66            414
Percent Heavy Vehicles      8             8
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage               /                     /
Lanes                          1       1
Configuration                   L      R
_______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service____________________
Approach            NB     SB          Westbound              Eastbound
Movement            1      4    |  7       8       9    |  10      11      12
Lane Config         L           |  L               R    |
_______________________________________________________________________________
v (vph)             17             66              414
C(m) (vph)          1000           119             253
v/c                 0.02           0.55            1.64
95% queue length    0.05           3.32            87.59
Control Delay       8.7            71.3            1200
LOS                  A              F               F
Approach Delay                             1045
Approach LOS                                F
_______________________________________________________________________________
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               HCS+: Unsignalized Intersections Release 5.6




Phone:                                       Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/2/2016
Analysis Time Period: AM Peak Hour - Construction
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                     17     1072                 244    283
Peak-Hour Factor, PHF      1.00   1.00                 1.00   1.00
Peak-15 Minute Volume      4      268                  61     71
Hourly Flow Rate, HFR      17     1072                 244    283
Percent Heavy Vehicles     10     --     --            --     --
Median Type/Storage         Undivided            /
RT Channelized?                                              No
Lanes                         1   1                    1    1
Configuration                  L  T                    T   R
Upstream Signal?                  No                   No
_______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
_______________________________________________________________________________
Volume                     66            414
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      16            104
Hourly Flow Rate, HFR      66            414
Percent Heavy Vehicles     8             8
Percent Grade (%)                 1                    0
Flared Approach:  Exists?/Storage                /                     /
RT Channelized?                          No
Lanes                         1       1
Configuration                  L      R
_______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                    13     14     15     16
_______________________________________________________________________________
Flow (ped/hr)                0      0      0      0
```

	1	2	3	4
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	10		8		8			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.7		6.4			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	10		8		8			
t(f)	2.3		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	527		1492		1072			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	1072	
Potential Capacity	253	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	253	
Probability of Queue free St.	0.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		527
Potential Capacity		1000
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1000
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1492	
Potential Capacity	121	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.98	0.00
Movement Capacity	119	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1492	
Potential Capacity	121	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.98	0.00
Movement Capacity	119	
Results for Two-stage process:		
a		
y		
C t	119	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	66		414			
Movement Capacity (vph)	119		253			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	119		253			
Volume	66		414			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	17		66		414			
C(m) (vph)	1000		119		253			
v/c	0.02		0.55		1.64			
95% queue length	0.05		3.32		87.59			
Control Delay	8.7		71.3		1200			
LOS	A		F		F			
Approach Delay				1045				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.7	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: PM Peak Hour - Construction
Intersection: I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2020
Project ID: FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street: I-94 WB Off Ramp
North/South Street: I-94BL
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	17	482			577	800
Peak-Hour Factor, PHF	1.00	1.00			1.00	1.00
Hourly Flow Rate, HFR	17	482			577	800
Percent Heavy Vehicles	0	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						No
Lanes	1	1			1	1
Configuration	L	T			T	R
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	54		99			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	54		99			
Percent Heavy Vehicles	6		23			
Percent Grade (%)		1			0	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	17		54		99			
C(m) (vph)	504		118		537			
v/c	0.03		0.46		0.18			
95% queue length	0.10		2.36		0.68			
Control Delay	12.4		60.6		13.2			
LOS	B		F		B			
Approach Delay				29.9				
Approach LOS				D				

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                 HCS+: Unsignalized Intersections Release 5.6



Phone:                                         Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Construction
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2020
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                  Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     17     482                   577    800
Peak-Hour Factor, PHF      1.00   1.00                  1.00   1.00
Peak-15 Minute Volume      4      120                   144    200
Hourly Flow Rate, HFR      17     482                   577    800
Percent Heavy Vehicles     0      --     --             --     --
Median Type/Storage         Undivided            /
RT Channelized?                                                No
Lanes                          1   1                    1    1
Configuration                    L  T                   T    R
Upstream Signal?                    No                  No
______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     54            99
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      14            25
Hourly Flow Rate, HFR      54            99
Percent Heavy Vehicles     6             23
Percent Grade (%)                 1                     0
Flared Approach:  Exists?/Storage               /                      /
RT Channelized?                          No
Lanes                          1        1
Configuration                    L       R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

```
Lane Width (ft)              12.0   12.0   12.0   12.0
Walking Speed (ft/sec)       4.0    4.0    4.0    4.0
Percent Blockage             0      0      0      0
______________________________________________________________________________

____________________________Upstream Signal Data______________________________
                 Prog.    Sat    Arrival   Green  Cycle   Prog.   Distance
                 Flow     Flow   Type      Time   Length  Speed   to Signal
                 vph      vph              sec    sec     mph     feet
______________________________________________________________________________
S2  Left-Turn
    Through
S5  Left-Turn
    Through
______________________________________________________________________________

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles
______________________________________________________________________________
                                           Movement 2     Movement 5
______________________________________________________________________________
Shared ln volume, major th vehicles:
Shared ln volume, major rt vehicles:
Sat flow rate, major th vehicles:
Sat flow rate, major rt vehicles:
Number of major street through lanes:
______________________________________________________________________________

Worksheet 4-Critical Gap and Follow-up Time Calculation
______________________________________________________________________________
Critical Gap Calculation
Movement           1      4      7      8      9      10     11     12
                   L      L      L      T      R      L      T      R
______________________________________________________________________________
t(c,base)        4.1           7.1           6.2
t(c,hv)          1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00
P(hv)            0             6             23
t(c,g)                         0.20   0.20   0.10   0.20   0.20   0.10
Percent Grade                  1.00   1.00   1.00   0.00   0.00   0.00
t(3,lt)          0.00          0.70          0.00
t(c,T):  1-stage 0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00
         2-stage 0.00   0.00   1.00   1.00   0.00   1.00   1.00   0.00
t(c)     1-stage 4.1           6.7           6.5
         2-stage
______________________________________________________________________________
Follow-Up Time Calculations
Movement           1      4      7      8      9      10     11     12
                   L      L      L      T      R      L      T      R
______________________________________________________________________________
t(f,base)        2.20          3.50          3.30
t(f,HV)          0.90   0.90   0.90   0.90   0.90   0.90   0.90   0.90
P(HV)            0             6             23
t(f)             2.2           3.6           3.5
______________________________________________________________________________

Worksheet 5-Effect of Upstream Signals
______________________________________________________________________________
Computation 1-Queue Clearance Time at Upstream Signal
                                            Movement 2        Movement 5
                                         V(t)   V(l,prot)  V(t)   V(l,prot)
______________________________________________________________________________
V prog
```

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
V c,x	1377		1493		482			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	482	
Potential Capacity	537	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	537	
Probability of Queue free St.	0.82	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		1377
Potential Capacity		504
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		504
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1493	
Potential Capacity	122	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.97
Cap. Adj. factor due to Impeding mvmnt	0.97	0.79
Movement Capacity	118	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1493	
Potential Capacity	122	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.97
Cap. Adj. factor due to Impeding mvmnt	0.97	0.79
Movement Capacity	118	

Results for Two-stage process:		
a		
y		
C t	118	

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	54		99			
Movement Capacity (vph)	118		537			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	118		537			
Volume	54		99			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	17		54		99			
C(m) (vph)	504		118		537			
v/c	0.03		0.46		0.18			
95% queue length	0.10		2.36		0.68			
Control Delay	12.4		60.6		13.2			
LOS	B		F		B			
Approach Delay				29.9				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	12.4	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

HCS Analysis Results

For Site 2

Exit 88

Intersections on Southside & Northside of Interstate

Operation Traffic Condition

```
                    HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY__________________________

Analyst:                Kevin Harder
Agency/Co.:             B&V
Date Performed:         3/4/2016
Analysis Time Period: AM Peak Hour - Operations
Intersection:           I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:          2022
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:       I-94 EB Off Ramp
North/South Street:     I-94BL
Intersection Orientation: NS                  Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments________________________
Major Street:  Approach        Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
_____________________________________________________________________________
Volume                             229    55       163    162
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              229    55       163    162
Percent Heavy Vehicles             --     --       22     --     --
Median Type/Storage         Undivided              /
RT Channelized?                           No
Lanes                              1    1             1   1
Configuration                      T   R               L  T
Upstream Signal?                   No                     No
_____________________________________________________________________________
Minor Street:  Approach        Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
_____________________________________________________________________________
Volume                      4             717
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       4             717
Percent Heavy Vehicles      50            3
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage                  /                      /
Lanes                           1        1
Configuration                    L      R
_____________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach          NB     SB        Westbound            Eastbound
Movement           1      4   |  7      8      9    |  10     11     12
Lane Config               L   |  L             R    |
_____________________________________________________________________________
v (vph)                  163    4             717
C(m) (vph)               1172   275           803
v/c                      0.14   0.01          0.89
95% queue length         0.48   0.04          17.71
Control Delay            8.6    18.3          41.5
LOS                       A      C             E
Approach Delay                         41.4
Approach LOS                            E
_____________________________________________________________________________
```

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Operations
Intersection: I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2022
Project ID: FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street: I-94 EB Off Ramp
North/South Street: I-94BL
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1 L		2 T		3 R	4 L		5 T	6 R
Volume			229		55	163		162	
Peak-Hour Factor, PHF			1.00		1.00	1.00		1.00	
Peak-15 Minute Volume			57		14	41		40	
Hourly Flow Rate, HFR			229		55	163		162	
Percent Heavy Vehicles			--		--	22		--	--
Median Type/Storage	Undivided					/			
RT Channelized?					No				
Lanes			1	1			1	1	
Configuration			T	R			L	T	
Upstream Signal?			No					No	

Minor Street Movements	7 L		8 T	9 R	10 L	11 T	12 R	
Volume	4			717				
Peak Hour Factor, PHF	1.00			1.00				
Peak-15 Minute Volume	1			179				
Hourly Flow Rate, HFR	4			717				
Percent Heavy Vehicles	50			3				
Percent Grade (%)			1			0		
Flared Approach: Exists?/Storage					/			/
RT Channelized?				No				
Lanes		1		1				
Configuration		L	R					

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		22	50		3			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.3	7.1		6.3			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		22	50		3			
t(f)		2.4	4.0		3.3			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Two-Stage Process Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		284	717		229			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	229	
Potential Capacity	803	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	803	
Probability of Queue free St.	0.11	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	284	
Potential Capacity	1172	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1172	
Probability of Queue free St.	0.86	1.00
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	717	
Potential Capacity	320	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.86
Maj. L, Min T Adj. Imp Factor.		0.89
Cap. Adj. factor due to Impeding mvmnt	0.86	0.10
Movement Capacity	275	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.86	0.86
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	717	
Potential Capacity	320	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.86
Maj. L, Min T Adj. Imp Factor.		0.89
Cap. Adj. factor due to Impeding mvmnt	0.86	0.10
Movement Capacity	275	
Results for Two-stage process:		
a		
y		
C t	275	

Worksheet 8-Shared Lane Calculations

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (vph)	4		717			
Movement Capacity (vph)	275		803			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	275		803			
Volume	4		717			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		R			
v (vph)		163	4		717			
C(m) (vph)		1172	275		803			
v/c		0.14	0.01		0.89			
95% queue length		0.48	0.04		17.71			
Control Delay		8.6	18.3		41.5			
LOS		A	C		E			
Approach Delay				41.4				
Approach LOS				E				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.86
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		8.6
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

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______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operations
Intersection:         I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:     I-94 EB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                Study period (hrs):  1.00

_____________________Vehicle Volumes and Adjustments________________________
Major Street:  Approach       Northbound             Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
_____________________________________________________________________________
Volume                             170    76       399    241
Peak-Hour Factor, PHF              1.00   1.00     1.00   1.00
Hourly Flow Rate, HFR              170    76       399    241
Percent Heavy Vehicles             --     --       7      --     --
Median Type/Storage         Undivided             /
RT Channelized?                               No
Lanes                              1    1             1    1
Configuration                      T    R              L   T
Upstream Signal?                   No                     No

_____________________________________________________________________________
Minor Street:  Approach       Westbound              Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
_____________________________________________________________________________
Volume                      4             309
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       4             309
Percent Heavy Vehicles      0             6
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage                /                     /
Lanes                          1        1
Configuration                   L      R
_____________________________________________________________________________

__________________Delay, Queue Length, and Level of Service__________________
Approach           NB     SB         Westbound              Eastbound
Movement           1      4    |  7       8       9     |  10     11     12
Lane Config               L    |  L               R     |
_____________________________________________________________________________
v (vph)                   399     4               309
C(m) (vph)                1291    132             859
v/c                       0.31    0.03            0.36
95% queue length          1.34    0.09            1.68
Control Delay             9.0     33.1            11.5
LOS                        A       D               B
Approach Delay                            11.8
Approach LOS                               B
_____________________________________________________________________________
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Phone:                                              Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operations
Intersection:         I-94 & I-94BL S. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & I-94 BL Interchange S. Side, Exit 92
East/West Street:     I-94 EB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
_____________________________________________________________________________
Volume                             170    76     399    241
Peak-Hour Factor, PHF              1.00   1.00   1.00   1.00
Peak-15 Minute Volume              42     19     100    60
Hourly Flow Rate, HFR              170    76     399    241
Percent Heavy Vehicles             --     --     7      --     --
Median Type/Storage         Undivided             /
RT Channelized?                               No
Lanes                              1    1           1    1
Configuration                      T    R            L   T
Upstream Signal?                   No                    No
_____________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
_____________________________________________________________________________
Volume                      4             309
Peak Hour Factor, PHF       1.00          1.00
Peak-15 Minute Volume       1             77
Hourly Flow Rate, HFR       4             309
Percent Heavy Vehicles      0             6
Percent Grade (%)                  1                     0
Flared Approach:  Exists?/Storage               /                      /
RT Channelized?                           No
Lanes                          1        1
Configuration                   L      R
_____________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
_____________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1	7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		7	0		6			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)		0.00	0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage		4.2	6.6		6.4			
2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)		2.20	3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		7	0		6			
t(f)		2.3	3.5		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p		0.000		0.000

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x		246	1209		170			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	170	
Potential Capacity	859	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	859	
Probability of Queue free St.	0.64	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows	246	
Potential Capacity	1291	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1291	
Probability of Queue free St.	0.69	1.00
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.69	0.69
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1209	
Potential Capacity	191	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.69
Maj. L, Min T Adj. Imp Factor.		0.76
Cap. Adj. factor due to Impeding mvmnt	0.69	0.49
Movement Capacity	132	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.69	0.69
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1209	
Potential Capacity	191	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.69
Maj. L, Min T Adj. Imp Factor.		0.76
Cap. Adj. factor due to Impeding mvmnt	0.69	0.49
Movement Capacity	132	
Results for Two-stage process:		
a		
y		
C t	132	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	4		309			
Movement Capacity (vph)	132		859			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	132		859			
Volume	4		309			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		L	L		R			
v (vph)		399	4		309			
C(m) (vph)		1291	132		859			
v/c		0.31	0.03		0.36			
95% queue length		1.34	0.09		1.68			
Control Delay		9.0	33.1		11.5			
LOS		A	D		B			
Approach Delay				11.8				
Approach LOS				B				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.69
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4		9.0
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

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TWO-WAY STOP CONTROL SUMMARY

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Operation
Intersection: I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2022
Project ID: FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street: I-94 WB Off Ramp
North/South Street: I-94BL
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	17	917			278	309
Peak-Hour Factor, PHF	1.00	0.99			1.00	1.00
Hourly Flow Rate, HFR	17	926			278	309
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						No
Lanes	1	1			1	1
Configuration	L	T			T	R
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	67		434			
Peak Hour Factor, PHF	1.00		1.00			
Hourly Flow Rate, HFR	67		434			
Percent Heavy Vehicles	8		7			
Percent Grade (%)		1			0	
Flared Approach: Exists?/Storage			/			/
Lanes	1		1			
Configuration	L		R			

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	17		67		434			
C(m) (vph)	950		137		311			
v/c	0.02		0.49		1.40			
95% queue length	0.05		2.67		70.71			
Control Delay	8.9		55.8		767.2			
LOS	A		F		F			
Approach Delay				672.1				
Approach LOS				F				

HCS+: Unsignalized Intersections Release 5.6

Phone: Fax:
E-Mail:

TWO-WAY STOP CONTROL(TWSC) ANALYSIS

Analyst: Kevin Harder
Agency/Co.: B&V
Date Performed: 3/4/2016
Analysis Time Period: AM Peak Hour - Operation
Intersection: I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year: 2022
Project ID: FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street: I-94 WB Off Ramp
North/South Street: I-94BL
Intersection Orientation: NS Study period (hrs): 1.00

Vehicle Volumes and Adjustments

Major Street Movements	1	2	3	4	5	6
	L	T	R	L	T	R
Volume	17	917			278	309
Peak-Hour Factor, PHF	1.00	0.99			1.00	1.00
Peak-15 Minute Volume	4	232			70	77
Hourly Flow Rate, HFR	17	926			278	309
Percent Heavy Vehicles	10	--	--		--	--
Median Type/Storage	Undivided			/		
RT Channelized?						No
Lanes	1	1			1	1
Configuration	L	T			T	R
Upstream Signal?		No			No	

Minor Street Movements	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	67		434			
Peak Hour Factor, PHF	1.00		1.00			
Peak-15 Minute Volume	17		108			
Hourly Flow Rate, HFR	67		434			
Percent Heavy Vehicles	8		7			
Percent Grade (%)		1			0	
Flared Approach: Exists?/Storage			/			/
RT Channelized?			No			
Lanes	1		1			
Configuration	L		R			

Pedestrian Volumes and Adjustments

Movements	13	14	15	16
Flow (ped/hr)	0	0	0	0
Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

	Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2 Left-Turn							
Through							
S5 Left-Turn							
Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)	10		8		7			
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade			1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)	0.00		0.70		0.00			
t(c,T): 1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c) 1-stage	4.2		6.7		6.4			
2-stage								

Follow-Up Time Calculations

Movement	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	10		8		7			
t(f)	2.3		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
V prog				

Total Saturation Flow Rate, s (vph)	
Arrival Type	
Effective Green, g (sec)	
Cycle Length, C (sec)	
Rp (from Exhibit 16-11)	
Proportion vehicles arriving on green P	
g(q1)	
g(q2)	
g(q)	

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2		Movement 5	
	V(t)	V(l,prot)	V(t)	V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5
Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	587		1392		926			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7		8		10		11	
	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	926	
Potential Capacity	311	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	311	
Probability of Queue free St.	0.00	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		587
Potential Capacity		950
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		950
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1392	
Potential Capacity	140	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.98	0.00
Movement Capacity	137	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		

Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		

Part 3 - Single Stage		
Conflicting Flows	1392	
Potential Capacity	140	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.98
Maj. L, Min T Adj. Imp Factor.		0.99
Cap. Adj. factor due to Impeding mvmnt	0.98	0.00
Movement Capacity	137	

Results for Two-stage process:		
a		
y		
C t	137	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	67		434			
Movement Capacity (vph)	137		311			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7 L	8 T	9 R	10 L	11 T	12 R
C sep	137		311			
Volume	67		434			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	17		67		434			
C(m) (vph)	950		137		311			
v/c	0.02		0.49		1.40			
95% queue length	0.05		2.67		70.71			
Control Delay	8.9		55.8		767.2			
LOS	A		F		F			
Approach Delay				672.1				
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.98	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	8.9	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

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               HCS+: Unsignalized Intersections Release 5.6

_______________________TWO-WAY STOP CONTROL SUMMARY___________________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operation
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

______________________Vehicle Volumes and Adjustments_________________________
Major Street:  Approach       Northbound              Southbound
               Movement     1      2      3     |  4      5      6
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      17     513                    578    662
Peak-Hour Factor, PHF       1.00   1.00                   1.00   1.00
Hourly Flow Rate, HFR       17     513                    578    662
Percent Heavy Vehicles      0      --     --              --     --
Median Type/Storage         Undivided            /
RT Channelized?                                               No
Lanes                          1   1                      1    1
Configuration                   L  T                      T   R
Upstream Signal?                   No                     No
______________________________________________________________________________
Minor Street:  Approach       Westbound               Eastbound
               Movement     7      8      9     |  10     11     12
                            L      T      R     |  L      T      R
______________________________________________________________________________
Volume                      55            129
Peak Hour Factor, PHF       1.00          1.00
Hourly Flow Rate, HFR       55            129
Percent Heavy Vehicles      6             16
Percent Grade (%)                  1                      0
Flared Approach:  Exists?/Storage                /                     /
Lanes                          1       1
Configuration                   L      R
______________________________________________________________________________

__________________Delay, Queue Length, and Level of Service___________________
Approach            NB     SB          Westbound              Eastbound
Movement            1      4    |  7      8       9     |  10      11     12
Lane Config         L           |  L              R     |
______________________________________________________________________________
v (vph)             17             55             129
C(m) (vph)          569            125            527
v/c                 0.03           0.44           0.24
95% queue length    0.09           2.22           0.97
Control Delay       11.5           55.9           14.0
LOS                  B              F              B
Approach Delay                               26.6
Approach LOS                                  D
______________________________________________________________________________
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               HCS+: Unsignalized Intersections Release 5.6

Phone:                                          Fax:
E-Mail:

______________________TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____________________

Analyst:              Kevin Harder
Agency/Co.:           B&V
Date Performed:       3/4/2016
Analysis Time Period: PM Peak Hour - Operation
Intersection:         I-94 & I-94BL N. Side, Exit 92
Jurisdiction:
Units: U. S. Customary
Analysis Year:        2022
Project ID:  FCTC I-94 & I-94 BL Interchange N. Side, Exit 92
East/West Street:     I-94 WB Off Ramp
North/South Street:   I-94BL
Intersection Orientation: NS                 Study period (hrs):  1.00

________________________Vehicle Volumes and Adjustments_______________________
Major Street Movements      1      2      3      4      5      6
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     17     513                  578    662
Peak-Hour Factor, PHF      1.00   1.00                 1.00   1.00
Peak-15 Minute Volume      4      128                  144    166
Hourly Flow Rate, HFR      17     513                  578    662
Percent Heavy Vehicles     0      --     --            --     --
Median Type/Storage         Undivided            /
RT Channelized?                                               No
Lanes                         1   1                    1    1
Configuration                  L  T                    T   R
Upstream Signal?                  No                   No
______________________________________________________________________________
Minor Street Movements      7      8      9      10     11     12
                            L      T      R      L      T      R
______________________________________________________________________________
Volume                     55            129
Peak Hour Factor, PHF      1.00          1.00
Peak-15 Minute Volume      14            32
Hourly Flow Rate, HFR      55            129
Percent Heavy Vehicles     6             16
Percent Grade (%)                 1                    0
Flared Approach:  Exists?/Storage                /                     /
RT Channelized?                          No
Lanes                         1       1
Configuration                  L      R
______________________________________________________________________________

______________________Pedestrian Volumes and Adjustments______________________
Movements                     13     14     15     16
______________________________________________________________________________
Flow (ped/hr)                 0      0      0      0
```

Lane Width (ft)	12.0	12.0	12.0	12.0
Walking Speed (ft/sec)	4.0	4.0	4.0	4.0
Percent Blockage	0	0	0	0

Upstream Signal Data

		Prog. Flow vph	Sat Flow vph	Arrival Type	Green Time sec	Cycle Length sec	Prog. Speed mph	Distance to Signal feet
S2	Left-Turn							
	Through							
S5	Left-Turn							
	Through							

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		
Shared ln volume, major rt vehicles:		
Sat flow rate, major th vehicles:		
Sat flow rate, major rt vehicles:		
Number of major street through lanes:		

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical Gap Calculation

Movement		1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(c,base)		4.1		7.1		6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		0		6		16			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent Grade				1.00	1.00	1.00	0.00	0.00	0.00
t(3,lt)		0.00		0.70		0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.1		6.7		6.5			
	2-stage								

Follow-Up Time Calculations

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
t(f,base)	2.20		3.50		3.30			
t(f,HV)	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)	0		6		16			
t(f)	2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
V prog				
Total Saturation Flow Rate, s (vph)				
Arrival Type				
Effective Green, g (sec)				
Cycle Length, C (sec)				
Rp (from Exhibit 16-11)				
Proportion vehicles arriving on green P				
g(q1)				
g(q2)				
g(q)				

Computation 2-Proportion of TWSC Intersection Time blocked

	Movement 2 V(t)	Movement 2 V(l,prot)	Movement 5 V(t)	Movement 5 V(l,prot)
alpha				
beta				
Travel time, t(a) (sec)				
Smoothing Factor, F				
Proportion of conflicting flow, f				
Max platooned flow, V(c,max)				
Min platooned flow, V(c,min)				
Duration of blocked period, t(p)				
Proportion time blocked, p	0.000		0.000	

Computation 3-Platoon Event Periods	Result
p(2)	0.000
p(5)	0.000
p(dom)	
p(subo)	
Constrained or unconstrained?	

Proportion unblocked for minor movements, p(x)	(1) Single-stage Process	(2) Two-Stage Process Stage I	(3) Stage II
p(1)			
p(4)			
p(7)			
p(8)			
p(9)			
p(10)			
p(11)			
p(12)			

Computation 4 and 5

Single-Stage Process

Movement	1 L	4 L	7 L	8 T	9 R	10 L	11 T	12 R
V c,x	1240		1456		513			
s								
Px								
V c,u,x								
C r,x								
C plat,x								

Two-Stage Process

	7	8	10	11

	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2	Stage1	Stage2
V(c,x)								
s		1500						
P(x)								
V(c,u,x)								
C(r,x)								
C(plat,x)								

Worksheet 6-Impedance and Capacity Equations

Step 1: RT from Minor St.	9	12
Conflicting Flows	513	
Potential Capacity	527	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	527	
Probability of Queue free St.	0.76	1.00

Step 2: LT from Major St.	4	1
Conflicting Flows		1240
Potential Capacity		569
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		569
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		

Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Conflicting Flows	1456	
Potential Capacity	129	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.97	0.74
Movement Capacity	125	

Worksheet 7-Computation of the Effect of Two-stage Gap Acceptance

Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Probability of Queue free St.		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity		
Result for 2 stage process:		
a		
y		
C t		
Probability of Queue free St.	1.00	1.00

Step 4: LT from Minor St.	7	10
Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 2 - Second Stage		
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor		
Cap. Adj. factor due to Impeding mvmnt		
Movement Capacity		
Part 3 - Single Stage		
Conflicting Flows	1456	
Potential Capacity	129	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.97
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.97	0.74
Movement Capacity	125	
Results for Two-stage process:		
a		
y		
C t	125	

Worksheet 8-Shared Lane Calculations

Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph)	55		129			
Movement Capacity (vph)	125		527			
Shared Lane Capacity (vph)						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	125		527			
Volume	55		129			
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh						
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	L		L		R			
v (vph)	17		55		129			
C(m) (vph)	569		125		527			
v/c	0.03		0.44		0.24			
95% queue length	0.09		2.22		0.97			
Control Delay	11.5		55.9		14.0			
LOS	B		F		B			
Approach Delay				26.6				
Approach LOS				D				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5		
v(i2), Volume for stream 3 or 6		
s(il), Saturation flow rate for stream 2 or 5		
s(i2), Saturation flow rate for stream 3 or 6		
P*(oj)		
d(M,LT), Delay for stream 1 or 4	11.5	
N, Number of major street through lanes		
d(rank,1) Delay for stream 2 or 5		

Appendix G.2

CRJMTC Site

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HCS Analysis Results

Existing Traffic Condition

```
                  HCS 2010: Two-Lane Highways Release 6.1


Phone:                                   Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                  Kevin Harder
Agency/Co.               B&V
Date Performed           2/17/2015
Analysis Time Period     Existing Peak Hour
Highway                  SR 5
From/To
Jurisdiction             (near CRJMTC Main Entrance)
Analysis Year            2015
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1               Peak hour factor, PHF    1.00
Shoulder width       3.0     ft      % Trucks and buses       7       %
Lane width           12.0    ft      % Trucks crawling        0.0     %
Segment length       0.0     mi      Truck crawl speed        0.0     mi/hr
Terrain type         Level           % Recreational vehicles  0       %
Grade:  Length       -       mi      % No-passing zones       14      %
        Up/down      -       %       Access point density     8       /mi

Analysis direction volume, Vd  314     veh/h
Opposing direction volume, Vo  313     veh/h

____________________________Average Travel Speed______________________________

Direction                              Analysis(d)         Opposing (o)
PCE for trucks, ET                         1.4                 1.4
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.973               0.973
Grade adj. factor,(note-1) fg              1.00                1.00
Directional flow rate,(note-2) vi          323     pc/h        322     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      2.0     mi/h

Free-flow speed, FFSd                          55.4    mi/h

Adjustment for no-passing zones, fnp           1.4     mi/h
Average travel speed, ATSd                     49.0    mi/h
Percent Free Flow Speed, PFFS                  88.4    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.993		0.993	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	316	pc/h	315	pc/h
Base percent time-spent-following,(note-4) BPTSFd	35.3	%		
Adjustment for no-passing zones, fnp	31.0			
Percent time-spent-following, PTSFd	50.8	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.20	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3195	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	49.0	mi/h
Percent time-spent-following, PTSFd (from above)	50.8	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	314.0
Effective width of outside lane, We	15.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	5.49
Bicycle LOS	E

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	2/17/2015
Analysis Time Period	Existing Peak Hour
Highway	SR 225
From/To	
Jurisdiction	(between I-76 & SR 5))
Analysis Year	2015
Description	CRJMTC Regional Roads - CIS EIS

Input Data

Highway class	Class 3		Peak hour factor, PHF	1.00	
Shoulder width	2.0	ft	% Trucks and buses	10	%
Lane width	10.0	ft	% Trucks crawling	0.0	%
Segment length	0.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	70	%
Up/down	-	%	Access point density	29	/mi

Analysis direction volume, Vd 76 veh/h
Opposing direction volume, Vo 76 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.7		2.7	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.855		0.855	
Grade adj. factor,(note-1) fg	0.67		0.67	
Directional flow rate,(note-2) vi	133	pc/h	133	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	50.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	3.7	mi/h
Adj. for access point density,(note-3) fA	7.3	mi/h
Free-flow speed, FFSd	39.0	mi/h
Adjustment for no-passing zones, fnp	2.4	mi/h
Average travel speed, ATSd	34.5	mi/h
Percent Free Flow Speed, PFFS	88.5	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.9		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.917		0.917	
Grade adjustment factor,(note-1) fg	0.73		0.73	
Directional flow rate,(note-2) vi	113	pc/h	113	pc/h
Base percent time-spent-following,(note-4) BPTSFd	13.0	%		
Adjustment for no-passing zones, fnp	51.8			
Percent time-spent-following, PTSFd	38.9	%		

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.09	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1651	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3107	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	34.5	mi/h
Percent time-spent-following, PTSFd (from above)	38.9	
Level of service, LOSd (from above)	B	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

```
Posted speed limit, Sp                                      45
Percent of segment with occupied on-highway parking         0
Pavement rating, P                                          3
Flow rate in outside lane, vOL                              76.0
Effective width of outside lane, We                         19.44
Effective speed factor, St                                  4.42
Bicycle LOS Score, BLOS                                     4.81
Bicycle LOS                                                 E

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                   Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis_______________

Analyst                  Kevin Harder
Agency/Co.               B&V
Date Performed           2/17/2015
Analysis Time Period     Existing Peak Hour
Highway                  SR 44/5
From/To
Jurisdiction             (between I-76 & SR 14)
Analysis Year            2015
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1              Peak hour factor, PHF      1.00
Shoulder width       8.0     ft     % Trucks and buses         7       %
Lane width           12.0    ft     % Trucks crawling          0.0     %
Segment length       0.0     mi     Truck crawl speed          0.0     mi/hr
Terrain type         Level          % Recreational vehicles    0       %
Grade:  Length       -       mi     % No-passing zones         55      %
        Up/down      -       %      Access point density       2       /mi

Analysis direction volume, Vd  655     veh/h
Opposing direction volume, Vo  655     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.1                 1.1
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.993               0.993
Grade adj. factor,(note-1) fg             1.00                1.00
Directional flow rate,(note-2) vi         660     pc/h        660     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM                -      mi/h
Observed total demand,(note-3) V                  -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS               60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS    0.0     mi/h
Adj. for access point density,(note-3) fA        0.5     mi/h

Free-flow speed, FFSd                            59.5    mi/h

Adjustment for no-passing zones, fnp             1.4     mi/h
Average travel speed, ATSd                       47.9    mi/h
Percent Free Flow Speed, PFFS                    80.5    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	655	pc/h	655	pc/h
Base percent time-spent-following,(note-4) BPTSFd	61.4	%		
Adjustment for no-passing zones, fnp	28.2			
Percent time-spent-following, PTSFd	75.5	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.41	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3200	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	47.9	mi/h
Percent time-spent-following, PTSFd (from above)	75.5	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	655.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.07
Bicycle LOS	C

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          2/17/2015
Analysis Time Period    Existing Peak Hour
Highway                 SR 14
From/To
Jurisdiction            (just northwest of Ravenna)
Analysis Year           2015
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 3             Peak hour factor, PHF    1.00
Shoulder width       3.0     ft     % Trucks and buses       9       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.0     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       70      %
        Up/down      -       %      Access point density     17      /mi

Analysis direction volume, Vd  764     veh/h
Opposing direction volume, Vo  764     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.1                 1.1
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.991               0.991
Grade adj. factor,(note-1) fg             1.00                1.00
Directional flow rate,(note-2) vi         771     pc/h        771     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM             -      mi/h
Observed total demand,(note-3) V               -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS            60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6    mi/h
Adj. for access point density,(note-3) fA     4.3     mi/h

Free-flow speed, FFSd                         53.2    mi/h

Adjustment for no-passing zones, fnp          1.2     mi/h
Average travel speed, ATSd                    40.0    mi/h
Percent Free Flow Speed, PFFS                 75.2    %
```

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_________________________Percent Time-Spent-Following________________________

Direction                              Analysis(d)         Opposing (o)
PCE for trucks, ET                         1.0                 1.0
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adjustment factor, fHV       1.000               1.000
Grade adjustment factor,(note-1) fg        1.00                1.00
Directional flow rate,(note-2) vi          764     pc/h        764     pc/h
Base percent time-spent-following,(note-4) BPTSFd  67.9    %
Adjustment for no-passing zones, fnp               24.9
Percent time-spent-following, PTSFd                80.3    %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.48
Peak 15-min vehicle-miles of travel, VMT15         0       veh-mi
Peak-hour vehicle-miles of travel, VMT60           0       veh-mi
Peak 15-min total travel time, TT15                0.0     veh-h
Capacity from ATS, CdATS                           1700    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               3200    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.0     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      40.0    mi/h
Percent time-spent-following, PTSFd (from above)             80.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -      %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
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Posted speed limit, Sp                                   55
Percent of segment with occupied on-highway parking      0
Pavement rating, P                                       3
Flow rate in outside lane, vOL                           764.0
Effective width of outside lane, We                      15.00
Effective speed factor, St                               4.79
Bicycle LOS Score, BLOS                                  6.67
Bicycle LOS                                              F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                   Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis_______________

Analyst                  Kevin Harder
Agency/Co.               B&V
Date Performed           3/3/2016
Analysis Time Period     Existing Peak Hour
Highway                  SR 44
From/To
Jurisdiction             (just north of Ravenna)
Analysis Year            2015
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data_________________________________

Highway class  Class 1              Peak hour factor, PHF     1.00
Shoulder width       2.5     ft     % Trucks and buses        6       %
Lane width           10.0    ft     % Trucks crawling         0.0     %
Segment length       0.0     mi     Truck crawl speed         0.0     mi/hr
Terrain type         Level          % Recreational vehicles   0       %
Grade:  Length       -       mi     % No-passing zones        50      %
        Up/down      -       %      Access point density      33      /mi

Analysis direction volume, Vd  355     veh/h
Opposing direction volume, Vo  354     veh/h

____________________________Average Travel Speed______________________________

Direction                              Analysis(d)         Opposing (o)
PCE for trucks, ET                         1.3                 1.3
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV     0.982               0.982
Grade adj. factor,(note-1) fg              1.00                1.00
Directional flow rate,(note-2) vi          362     pc/h        360     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  3.7     mi/h
Adj. for access point density,(note-3) fA      8.3     mi/h

Free-flow speed, FFSd                          48.0    mi/h

Adjustment for no-passing zones, fnp           1.8     mi/h
Average travel speed, ATSd                     40.6    mi/h
Percent Free Flow Speed, PFFS                  84.5    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.994		0.994	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	357	pc/h	356	pc/h
Base percent time-spent-following,(note-4) BPTSFd	38.4	%		
Adjustment for no-passing zones, fnp	45.8			
Percent time-spent-following, PTSFd	61.3	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.23	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3191	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	40.6	mi/h
Percent time-spent-following, PTSFd (from above)	61.3	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	355.0
Effective width of outside lane, We	12.50
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	5.56
Bicycle LOS	F

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS Analysis Results

Construction Traffic Condition

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/3/2016
Analysis Time Period    Construction Peak Hour
Highway                 SR 5
From/To
Jurisdiction            (near CRJMTC Main Entrance)
Analysis Year           2020
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1              Peak hour factor, PHF    1.00
Shoulder width      3.0     ft      % Trucks and buses       5       %
Lane width          12.0    ft      % Trucks crawling        0.0     %
Segment length      0.0     mi      Truck crawl speed        0.0     mi/hr
Terrain type        Level           % Recreational vehicles  0       %
Grade:  Length      -       mi      % No-passing zones       14      %
        Up/down     -       %       Access point density     8       /mi

Analysis direction volume, Vd  776     veh/h
Opposing direction volume, Vo  366     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.1                 1.3
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.995               0.985
Grade adj. factor,(note-1) fg             1.00                1.00
Directional flow rate,(note-2) vi         780     pc/h        372     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM                -      mi/h
Observed total demand,(note-3) V                  -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS               60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS    2.6     mi/h
Adj. for access point density,(note-3) fA        2.0     mi/h

Free-flow speed, FFSd                            55.4    mi/h

Adjustment for no-passing zones, fnp             1.3     mi/h
Average travel speed, ATSd                       45.1    mi/h
Percent Free Flow Speed, PFFS                    81.4    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		0.995	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	776	pc/h	368	pc/h
Base percent time-spent-following,(note-4) BPTSFd	64.3	%		
Adjustment for no-passing zones, fnp	16.5			
Percent time-spent-following, PTSFd	75.5	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.46	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2510	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	45.1	mi/h
Percent time-spent-following, PTSFd (from above)	75.5	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	776.0
Effective width of outside lane, We	15.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	5.30
Bicycle LOS	E

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/3/2016
Analysis Time Period	Construction Peak Hour
Highway	SR 225
From/To	
Jurisdiction	(between I-76 & SR 5))
Analysis Year	2020
Description	CRJMTC Regional Roads - CIS EIS

Input Data

Highway class	Class 3		Peak hour factor, PHF	1.00	
Shoulder width	2.0	ft	% Trucks and buses	7	%
Lane width	10.0	ft	% Trucks crawling	0.0	%
Segment length	0.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Rolling		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	70	%
Up/down	-	%	Access point density	29	/mi

Analysis direction volume, Vd	153	veh/h
Opposing direction volume, Vo	85	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	2.5		2.7	
PCE for RVs, ER	1.1		1.1	
Heavy-vehicle adj. factor,(note-5) fHV	0.905		0.894	
Grade adj. factor,(note-1) fg	0.71		0.67	
Directional flow rate,(note-2) vi	238	pc/h	142	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	50.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	3.7	mi/h
Adj. for access point density,(note-3) fA	7.3	mi/h
Free-flow speed, FFSd	39.0	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	33.5	mi/h
Percent Free Flow Speed, PFFS	85.8	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.8		1.9	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.947		0.941	
Grade adjustment factor,(note-1) fg	0.77		0.73	
Directional flow rate,(note-2) vi	210	pc/h	124	pc/h
Base percent time-spent-following,(note-4) BPTSFd	22.5	%		
Adjustment for no-passing zones, fnp	50.9			
Percent time-spent-following, PTSFd	54.5	%		

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.14	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1664	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2657	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	33.5	mi/h
Percent time-spent-following, PTSFd (from above)	54.5	
Level of service, LOSd (from above)	B	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	153.0
Effective width of outside lane, We	14.82
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	4.93
Bicycle LOS	E

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/3/2016
Analysis Time Period	Construction Peak Hour
Highway	SR 44/5
From/To	
Jurisdiction	(between I-76 & SR 14)
Analysis Year	2020
Description	CRJMTC Regional Roads - CIS EIS

Input Data

Highway class	Class 1		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	7	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	0.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	55	%
Up/down	-	%	Access point density	8	/mi

Analysis direction volume, Vd	692	veh/h
Opposing direction volume, Vo	660	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.993		0.993	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	697	pc/h	665	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	2.0	mi/h
Free-flow speed, FFSd	58.0	mi/h
Adjustment for no-passing zones, fnp	1.4	mi/h
Average travel speed, ATSd	46.1	mi/h
Percent Free Flow Speed, PFFS	79.4	%

```
_________________________Percent Time-Spent-Following_________________________

Direction                              Analysis(d)         Opposing (o)
PCE for trucks, ET                         1.0                 1.0
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adjustment factor, fHV       1.000               1.000
Grade adjustment factor,(note-1) fg        1.00                1.00
Directional flow rate,(note-2) vi          692    pc/h         660     pc/h
Base percent time-spent-following,(note-4) BPTSFd  63.9   %
Adjustment for no-passing zones, fnp               26.8
Percent time-spent-following, PTSFd                77.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.44
Peak 15-min vehicle-miles of travel, VMT15         0       veh-mi
Peak-hour vehicle-miles of travel, VMT60           0       veh-mi
Peak 15-min total travel time, TT15                0.0     veh-h
Capacity from ATS, CdATS                           1700    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               3126    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.0     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      46.1    mi/h
Percent time-spent-following, PTSFd (from above)             77.6
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________

Posted speed limit, Sp                                     55
Percent of segment with occupied on-highway parking        0
Pavement rating, P                                         3
Flow rate in outside lane, vOL                             692.0
Effective width of outside lane, We                        28.00
Effective speed factor, St                                 4.79
Bicycle LOS Score, BLOS                                    3.09
Bicycle LOS                                                C

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/3/2016
Analysis Time Period	Construction Peak Hour
Highway	SR 14
From/To	
Jurisdiction	(just northwest of Ravenna)
Analysis Year	2020
Description	CRJMTC Regional Roads - CIS EIS

Input Data

Highway class	Class 3		Peak hour factor, PHF	1.00	
Shoulder width	3.0	ft	% Trucks and buses	9	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	0.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	70	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	920	veh/h
Opposing direction volume, Vo	782	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		0.991	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	920	pc/h	789	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	2.6	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	53.2	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	38.7	mi/h
Percent Free Flow Speed, PFFS	72.9	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	920	pc/h	782	pc/h
Base percent time-spent-following,(note-4) BPTSFd	73.3	%		
Adjustment for no-passing zones, fnp	21.8			
Percent time-spent-following, PTSFd	85.1	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.54	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3157	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	38.7	mi/h
Percent time-spent-following, PTSFd (from above)	85.1	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

```
Posted speed limit, Sp                                   55
Percent of segment with occupied on-highway parking      0
Pavement rating, P                                       3
Flow rate in outside lane, vOL                           920.0
Effective width of outside lane, We                      15.00
Effective speed factor, St                               4.79
Bicycle LOS Score, BLOS                                  6.76
Bicycle LOS                                              F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                   Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis_______________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/3/2016
Analysis Time Period    Construction Peak Hour
Highway                 SR 44
From/To
Jurisdiction            (just north of Ravenna)
Analysis Year           2020
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data_________________________________

Highway class  Class 1              Peak hour factor, PHF    1.00
Shoulder width      2.5     ft      % Trucks and buses       6       %
Lane width          10.0    ft      % Trucks crawling        0.0     %
Segment length      0.0     mi      Truck crawl speed        0.0     mi/hr
Terrain type        Level           % Recreational vehicles  0       %
Grade:  Length      -       mi      % No-passing zones       50      %
        Up/down     -       %       Access point density     33      /mi

Analysis direction volume, Vd  390     veh/h
Opposing direction volume, Vo  358     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.3                 1.3
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.982               0.982
Grade adj. factor,(note-1) fg             1.00                1.00
Directional flow rate,(note-2) vi         397     pc/h        365     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM             -      mi/h
Observed total demand,(note-3) V               -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS            60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS 3.7     mi/h
Adj. for access point density,(note-3) fA     8.3     mi/h

Free-flow speed, FFSd                         48.0    mi/h

Adjustment for no-passing zones, fnp          1.8     mi/h
Average travel speed, ATSd                    40.3    mi/h
Percent Free Flow Speed, PFFS                 83.9    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.994		0.994	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	392	pc/h	360	pc/h
Base percent time-spent-following,(note-4) BPTSFd	40.9	%		
Adjustment for no-passing zones, fnp	43.0			
Percent time-spent-following, PTSFd	63.3	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.25	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3071	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	40.3	mi/h
Percent time-spent-following, PTSFd (from above)	63.3	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	390.0
Effective width of outside lane, We	12.50
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	5.61
Bicycle LOS	F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS Analysis Results

Operations Traffic Condition

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Phone:                                   Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                  Kevin Harder
Agency/Co.               B&V
Date Performed           3/3/2016
Analysis Time Period     Operations Peak Hour
Highway                  SR 5
From/To
Jurisdiction             (near CRJMTC Main Entrance)
Analysis Year            2022
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1              Peak hour factor, PHF    1.00
Shoulder width       3.0     ft     % Trucks and buses       5       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.0     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       14      %
        Up/down      -       %      Access point density     8       /mi

Analysis direction volume, Vd  611     veh/h
Opposing direction volume, Vo  421     veh/h

____________________________Average Travel Speed______________________________

Direction                              Analysis(d)         Opposing (o)
PCE for trucks, ET                         1.1                 1.3
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV     0.995               0.985
Grade adj. factor,(note-1) fg              1.00                1.00
Directional flow rate,(note-2) vi          614     pc/h        427     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  2.6     mi/h
Adj. for access point density,(note-3) fA      2.0     mi/h

Free-flow speed, FFSd                          55.4    mi/h

Adjustment for no-passing zones, fnp           1.3     mi/h
Average travel speed, ATSd                     46.1    mi/h
Percent Free Flow Speed, PFFS                  83.2    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	611	pc/h	421	pc/h
Base percent time-spent-following,(note-4) BPTSFd	56.2	%		
Adjustment for no-passing zones, fnp	21.4			
Percent time-spent-following, PTSFd	68.9	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.36	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2882	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	46.1	mi/h
Percent time-spent-following, PTSFd (from above)	68.9	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	611.0
Effective width of outside lane, We	15.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	5.18
Bicycle LOS	E

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/3/2016
Analysis Time Period    Operatios Peak Hour
Highway                 SR 225
From/To
Jurisdiction            (between I-76 & SR 5))
Analysis Year           2022
Description  CRJMTC Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 3              Peak hour factor, PHF     1.00
Shoulder width       2.0     ft     % Trucks and buses        8       %
Lane width           10.0    ft     % Trucks crawling         0.0     %
Segment length       0.0     mi     Truck crawl speed         0.0     mi/hr
Terrain type         Rolling        % Recreational vehicles   0       %
Grade:  Length       -       mi     % No-passing zones        70      %
        Up/down      -       %      Access point density      29      /mi

Analysis direction volume, Vd  126     veh/h
Opposing direction volume, Vo  95      veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        2.6                 2.7
PCE for RVs, ER                           1.1                 1.1
Heavy-vehicle adj. factor,(note-5) fHV    0.887               0.880
Grade adj. factor,(note-1) fg             0.69                0.67
Directional flow rate,(note-2) vi         206     pc/h        161     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  3.7     mi/h
Adj. for access point density,(note-3) fA      7.3     mi/h

Free-flow speed, FFSd                          39.0    mi/h

Adjustment for no-passing zones, fnp           2.9     mi/h
Average travel speed, ATSd                     33.3    mi/h
Percent Free Flow Speed, PFFS                  85.4    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.8                 1.9
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.940               0.933
Grade adjustment factor,(note-1) fg       0.75                0.73
Directional flow rate,(note-2) vi         179     pc/h        140     pc/h
Base percent time-spent-following,(note-4) BPTSFd  19.6    %
Adjustment for no-passing zones, fnp               54.5
Percent time-spent-following, PTSFd                50.2    %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              B
Volume to capacity ratio, v/c                      0.12
Peak 15-min vehicle-miles of travel, VMT15         0       veh-mi
Peak-hour vehicle-miles of travel, VMT60           0       veh-mi
Peak 15-min total travel time, TT15                0.0     veh-h
Capacity from ATS, CdATS                           1661    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               2958    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.0     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      33.3    mi/h
Percent time-spent-following, PTSFd (from above)             50.2
Level of service, LOSd (from above)                          B

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	126.0
Effective width of outside lane, We	16.44
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	4.90
Bicycle LOS	E

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/3/2016
Analysis Time Period	Operations Peak Hour
Highway	SR 44/5
From/To	
Jurisdiction	(between I-76 & SR 14)
Analysis Year	2022
Description	CRJMTC Regional Roads - CIS EIS

Input Data

Highway class	Class 1		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	7	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	0.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	55	%
Up/down	-	%	Access point density	2	/mi

Analysis direction volume, Vd	679	veh/h
Opposing direction volume, Vo	663	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.993		0.993	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	684	pc/h	668	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	0.5	mi/h
Free-flow speed, FFSd	59.5	mi/h
Adjustment for no-passing zones, fnp	1.4	mi/h
Average travel speed, ATSd	47.6	mi/h
Percent Free Flow Speed, PFFS	80.1	%

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.0                 1.0
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      1.000               1.000
Grade adjustment factor,(note-1) fg       1.00                1.00
Directional flow rate,(note-2) vi         679    pc/h         663     pc/h
Base percent time-spent-following,(note-4) BPTSFd  63.0   %
Adjustment for no-passing zones, fnp               27.2
Percent time-spent-following, PTSFd                76.8   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.43
Peak 15-min vehicle-miles of travel, VMT15         0       veh-mi
Peak-hour vehicle-miles of travel, VMT60           0       veh-mi
Peak 15-min total travel time, TT15                0.0     veh-h
Capacity from ATS, CdATS                           1700    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               3162    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         0.0     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      47.6    mi/h
Percent time-spent-following, PTSFd (from above)             76.8
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

```
Posted speed limit, Sp                                     55
Percent of segment with occupied on-highway parking        0
Pavement rating, P                                         3
Flow rate in outside lane, vOL                             679.0
Effective width of outside lane, We                        28.00
Effective speed factor, St                                 4.79
Bicycle LOS Score, BLOS                                    3.08
Bicycle LOS                                                C

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/3/2016
Analysis Time Period	Operations Peak Hour
Highway	SR 14
From/To	
Jurisdiction	(just northwest of Ravenna)
Analysis Year	2022
Description	CRJMTC Regional Roads - CIS EIS

Input Data

Highway class	Class 3		Peak hour factor, PHF	1.00	
Shoulder width	3.0	ft	% Trucks and buses	9	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	0.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	70	%
Up/down	-	%	Access point density	17	/mi

Analysis direction volume, Vd	864	veh/h
Opposing direction volume, Vo	800	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		0.991	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	864	pc/h	807	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	2.6	mi/h
Adj. for access point density,(note-3) fA	4.3	mi/h
Free-flow speed, FFSd	53.2	mi/h
Adjustment for no-passing zones, fnp	1.1	mi/h
Average travel speed, ATSd	39.1	mi/h
Percent Free Flow Speed, PFFS	73.5	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	864	pc/h	800	pc/h
Base percent time-spent-following,(note-4) BPTSFd	71.5	%		
Adjustment for no-passing zones, fnp	22.6			
Percent time-spent-following, PTSFd	83.2	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.54	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3094	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	39.1	mi/h
Percent time-spent-following, PTSFd (from above)	83.2	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	864.0
Effective width of outside lane, We	15.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	6.73
Bicycle LOS	F

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/3/2016
Analysis Time Period	Operations Peak Hour
Highway	SR 44
From/To	
Jurisdiction	(just north of Ravenna)
Analysis Year	2022
Description	CRJMTC Regional Roads - CIS EIS

Input Data

Highway class	Class 1		Peak hour factor, PHF	1.00	
Shoulder width	2.5	ft	% Trucks and buses	6	%
Lane width	10.0	ft	% Trucks crawling	0.0	%
Segment length	0.0	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	50	%
Up/down	-	%	Access point density	33	/mi

Analysis direction volume, Vd	377	veh/h
Opposing direction volume, Vo	362	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.982		0.982	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	384	pc/h	369	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	3.7	mi/h
Adj. for access point density,(note-3) fA	8.3	mi/h
Free-flow speed, FFSd	48.0	mi/h
Adjustment for no-passing zones, fnp	1.8	mi/h
Average travel speed, ATSd	40.4	mi/h
Percent Free Flow Speed, PFFS	84.1	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.994		0.994	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	379	pc/h	364	pc/h
Base percent time-spent-following,(note-4) BPTSFd	41.2	%		
Adjustment for no-passing zones, fnp	44.0			
Percent time-spent-following, PTSFd	63.6	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.24	
Peak 15-min vehicle-miles of travel, VMT15	0	veh-mi
Peak-hour vehicle-miles of travel, VMT60	0	veh-mi
Peak 15-min total travel time, TT15	0.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3137	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.0	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	40.4	mi/h
Percent time-spent-following, PTSFd (from above)	63.6	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	377.0
Effective width of outside lane, We	12.50
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	5.59
Bicycle LOS	F

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Appendix G.3

FTD Site

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HCS Analysis Results

Existing Traffic Condition

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Phone:                                   Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/2/2016
Analysis Time Period    Existing Peak Hour
Highway                 SR 3(x)
From/To                 SR 3A to Carthage
Jurisdiction
Analysis Year           2016
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1              Peak hour factor, PHF    1.00
Shoulder width      8.0     ft      % Trucks and buses       15      %
Lane width          12.0    ft      % Trucks crawling        0.0     %
Segment length      2.7     mi      Truck crawl speed        0.0     mi/hr
Terrain type        Level           % Recreational vehicles  0       %
Grade:  Length      -       mi      % No-passing zones       50      %
        Up/down     -       %       Access point density     17      /mi

Analysis direction volume, Vd  86      veh/h
Opposing direction volume, Vo  77      veh/h

____________________________Average Travel Speed______________________________

Direction                              Analysis(d)         Opposing (o)
PCE for trucks, ET                         1.9                 1.9
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV     0.881               0.881
Grade adj. factor,(note-1) fg              1.00                1.00
Directional flow rate,(note-2) vi          98      pc/h        87      pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM               -      mi/h
Observed total demand,(note-3) V                 -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS              65.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  0.0     mi/h
Adj. for access point density,(note-3) fA      4.3     mi/h

Free-flow speed, FFSd                           60.8    mi/h

Adjustment for no-passing zones, fnp            2.2     mi/h
Average travel speed, ATSd                      57.2    mi/h
Percent Free Flow Speed, PFFS                   94.1    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                              Analysis(d)        Opposing (o)
PCE for trucks, ET                         1.1                 1.1
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adjustment factor, fHV       0.985               0.985
Grade adjustment factor,(note-1) fg        1.00                1.00
Directional flow rate,(note-2) vi          87      pc/h        78      pc/h
Base percent time-spent-following,(note-4) BPTSFd  10.2   %
Adjustment for no-passing zones, fnp               46.3
Percent time-spent-following, PTSFd                34.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              A
Volume to capacity ratio, v/c                      0.06
Peak 15-min vehicle-miles of travel, VMT15         58      veh-mi
Peak-hour vehicle-miles of travel, VMT60           232     veh-mi
Peak 15-min total travel time, TT15                1.0     veh-h
Capacity from ATS, CdATS                           1700    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               3020    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         2.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      57.2    mi/h
Percent time-spent-following, PTSFd (from above)             34.6
Level of service, LOSd (from above)                          A

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________

Posted speed limit, Sp                                       55
Percent of segment with occupied on-highway parking          0
Pavement rating, P                                           3
Flow rate in outside lane, vOL                               86.0
Effective width of outside lane, We                          39.40
Effective speed factor, St                                   4.79
Bicycle LOS Score, BLOS                                      1.60
Bicycle LOS                                                  B

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          2/3/2016
Analysis Time Period    Existing Peak Hour
Highway                 SR 3(y)
From/To                 Carthage to SR 3A
Jurisdiction            NB
Analysis Year           2016
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 2             Peak hour factor, PHF    1.00
Shoulder width       4.0     ft     % Trucks and buses       7       %
Lane width           11.0    ft     % Trucks crawling        0.0     %
Segment length       1.4     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       80      %
        Up/down      -       %      Access point density     38      /mi

Analysis direction volume, Vd  177     veh/h
Opposing direction volume, Vo  69      veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)        Opposing (o)
PCE for trucks, ET                        1.6                1.9
PCE for RVs, ER                           1.0                1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.960              0.941
Grade adj. factor,(note-1) fg             1.00               1.00
Directional flow rate,(note-2) vi         184     pc/h       73      pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             60.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  1.7     mi/h
Adj. for access point density,(note-3) fA      9.5     mi/h

Free-flow speed, FFSd                          48.8    mi/h

Adjustment for no-passing zones, fnp           2.4     mi/h
Average travel speed, ATSd                     44.5    mi/h
Percent Free Flow Speed, PFFS                  91.1    %
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_________________________Percent Time-Spent-Following________________________

Direction                               Analysis(d)        Opposing (o)
PCE for trucks, ET                          1.1                1.1
PCE for RVs, ER                             1.0                1.0
Heavy-vehicle adjustment factor, fHV        0.993              0.993
Grade adjustment factor,(note-1) fg         1.00               1.00
Directional flow rate,(note-2) vi           178     pc/h       69      pc/h
Base percent time-spent-following,(note-4) BPTSFd  19.5   %
Adjustment for no-passing zones, fnp               48.0
Percent time-spent-following, PTSFd                54.1   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              B
Volume to capacity ratio, v/c                      0.10
Peak 15-min vehicle-miles of travel, VMT15         62      veh-mi
Peak-hour vehicle-miles of travel, VMT60           248     veh-mi
Peak 15-min total travel time, TT15                1.4     veh-h
Capacity from ATS, CdATS                           1700    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               2358    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.4     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      44.5    mi/h
Percent time-spent-following, PTSFd (from above)             54.1
Level of service, LOSd (from above)                          B

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -      %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service _________________________
```

```
Posted speed limit, Sp
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            177.0
Effective width of outside lane, We                       15.00
Effective speed factor, St                                4.79
Bicycle LOS Score, BLOS                                   5.20
Bicycle LOS                                               E

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                       Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis_______________

Analyst                  Kevin Harder
Agency/Co.               B&V
Date Performed           3/2/2016
Analysis Time Period     Existing Peak Hour
Highway                  SR 3(z)
From/To                  Just N. of SR 3A
Jurisdiction             EB
Analysis Year            2016
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data_________________________________

Highway class  Class 3             Peak hour factor, PHF    1.00
Shoulder width       8.0     ft     % Trucks and buses       5       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.6     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
       Up/down       -       %      Access point density     40      /mi

Analysis direction volume, Vd  90      veh/h
Opposing direction volume, Vo  326     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.9                 1.4
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.957               0.980
Grade adj. factor,(note-1) fg             1.00                1.00
Directional flow rate,(note-2) vi         94      pc/h        333     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM             -      mi/h
Observed total demand,(note-3) V               -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS            50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  0.0    mi/h
Adj. for access point density,(note-3) fA     10.0    mi/h

Free-flow speed, FFSd                         40.0    mi/h

Adjustment for no-passing zones, fnp          3.1     mi/h
Average travel speed, ATSd                    33.6    mi/h
Percent Free Flow Speed, PFFS                 83.9    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.995		0.995	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	90	pc/h	328	pc/h
Base percent time-spent-following,(note-4) BPTSFd	12.3	%		
Adjustment for no-passing zones, fnp	44.5			
Percent time-spent-following, PTSFd	21.9	%		

Level of Service and Other Performance Measures

Level of service, LOS	B	
Volume to capacity ratio, v/c	0.20	
Peak 15-min vehicle-miles of travel, VMT15	14	veh-mi
Peak-hour vehicle-miles of travel, VMT60	54	veh-mi
Peak 15-min total travel time, TT15	0.4	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2179	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.6	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	33.6	mi/h
Percent time-spent-following, PTSFd (from above)	21.9	
Level of service, LOSd (from above)	B	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	90.0
Effective width of outside lane, We	39.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	-2.45
Bicycle LOS	A

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/2/2016
Analysis Time Period    Existing Peak Hour
Highway                 SR 26
From/To                 US 11 to 45 Inf Div Dr
Jurisdiction            EB
Analysis Year           2016
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1              Peak hour factor, PHF    1.00
Shoulder width       8.0     ft     % Trucks and buses       5       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       2.1     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       30      %
        Up/down      -       %      Access point density     5       /mi

Analysis direction volume, Vd  270     veh/h
Opposing direction volume, Vo  269     veh/h

____________________________Average Travel Speed______________________________

Direction                          Analysis(d)         Opposing (o)
PCE for trucks, ET                     1.4                 1.4
PCE for RVs, ER                        1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.980               0.980
Grade adj. factor,(note-1) fg          1.00                1.00
Directional flow rate,(note-2) vi      276     pc/h        274     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM             -      mi/h
Observed total demand,(note-3) V               -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS            65.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  0.0    mi/h
Adj. for access point density,(note-3) fA      1.3    mi/h

Free-flow speed, FFSd                         63.8    mi/h

Adjustment for no-passing zones, fnp          2.4     mi/h
Average travel speed, ATSd                    57.1    mi/h
Percent Free Flow Speed, PFFS                 89.6    %
```

```
_________________________Percent Time-Spent-Following________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.1                 1.1
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.995               0.995
Grade adjustment factor,(note-1) fg       1.00                1.00
Directional flow rate,(note-2) vi         271    pc/h         270     pc/h
Base percent time-spent-following,(note-4) BPTSFd  30.2    %
Adjustment for no-passing zones, fnp               44.3
Percent time-spent-following, PTSFd                52.4    %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.17
Peak 15-min vehicle-miles of travel, VMT15         142     veh-mi
Peak-hour vehicle-miles of travel, VMT60           567     veh-mi
Peak 15-min total travel time, TT15                2.5     veh-h
Capacity from ATS, CdATS                           1700    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               3188    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         2.1     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      57.1    mi/h
Percent time-spent-following, PTSFd (from above)             52.4
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	270.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	1.97
Bicycle LOS	B

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	2016
Analysis Time Period	Existing Peak Hour
Highway	SR 342
From/To	SR 37 to Bush Rd
Jurisdiction	EB
Analysis Year	2016
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.7	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	70	%
Up/down	-	%	Access point density	8	/mi

Analysis direction volume, Vd	710	veh/h
Opposing direction volume, Vo	709	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.995		0.995	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	714	pc/h	713	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	65.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	2.0	mi/h
Free-flow speed, FFSd	63.0	mi/h
Adjustment for no-passing zones, fnp	1.5	mi/h
Average travel speed, ATSd	50.4	mi/h
Percent Free Flow Speed, PFFS	80.1	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	710	pc/h	709	pc/h
Base percent time-spent-following,(note-4) BPTSFd	65.4	%		
Adjustment for no-passing zones, fnp	26.5			
Percent time-spent-following, PTSFd	78.7	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.44	
Peak 15-min vehicle-miles of travel, VMT15	302	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1207	veh-mi
Peak 15-min total travel time, TT15	6.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3197	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	1.7	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	50.4	mi/h
Percent time-spent-following, PTSFd (from above)	78.7	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	710.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	2.46
Bicycle LOS	B

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	Existing Peak Hour
Highway	US 11
From/To	SR 37 North 2.4 miles
Jurisdiction	EB
Analysis Year	2016
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.4	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	50	%
Up/down	-	%	Access point density	32	/mi

Analysis direction volume, Vd 475 veh/h
Opposing direction volume, Vo 474 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.2	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.990		0.990	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	480	pc/h	479	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	65.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	8.0	mi/h
Free-flow speed, FFSd	57.0	mi/h
Adjustment for no-passing zones, fnp	1.9	mi/h
Average travel speed, ATSd	47.7	mi/h
Percent Free Flow Speed, PFFS	83.7	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	475	pc/h	474	pc/h
Base percent time-spent-following,(note-4) BPTSFd	49.3	%		
Adjustment for no-passing zones, fnp	37.9			
Percent time-spent-following, PTSFd	68.3	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.30	
Peak 15-min vehicle-miles of travel, VMT15	285	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1140	veh-mi
Peak 15-min total travel time, TT15	6.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3196	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.4	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	47.7	mi/h
Percent time-spent-following, PTSFd (from above)	68.3	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	475.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	2.26
Bicycle LOS	B

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS Analysis Results

Construction Traffic Condition

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/2/2016
Analysis Time Period    Construction Peak Hour
Highway                 SR 3(x)
From/To                 SR 3A to Carthage
Jurisdiction
Analysis Year           2022
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1             Peak hour factor, PHF    1.00
Shoulder width       8.0     ft     % Trucks and buses       9       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       2.7     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       50      %
        Up/down      -       %      Access point density     17      /mi

Analysis direction volume, Vd  246     veh/h
Opposing direction volume, Vo  73      veh/h

____________________________Average Travel Speed______________________________

Direction                           Analysis(d)        Opposing (o)
PCE for trucks, ET                      1.5                 1.9
PCE for RVs, ER                         1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.957               0.925
Grade adj. factor,(note-1) fg           1.00                1.00
Directional flow rate,(note-2) vi       257     pc/h        79      pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             65.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  0.0     mi/h
Adj. for access point density,(note-3) fA      4.3     mi/h

Free-flow speed, FFSd                          60.8    mi/h

Adjustment for no-passing zones, fnp           2.2     mi/h
Average travel speed, ATSd                     56.0    mi/h
Percent Free Flow Speed, PFFS                  92.2    %
```

```
_________________________Percent Time-Spent-Following_________________________

Direction                             Analysis(d)        Opposing (o)
PCE for trucks, ET                        1.1                 1.1
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adjustment factor, fHV      0.991               0.991
Grade adjustment factor,(note-1) fg       1.00                1.00
Directional flow rate,(note-2) vi         248     pc/h        74      pc/h
Base percent time-spent-following,(note-4) BPTSFd  25.9    %
Adjustment for no-passing zones, fnp               40.8
Percent time-spent-following, PTSFd                57.3    %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              C
Volume to capacity ratio, v/c                      0.15
Peak 15-min vehicle-miles of travel, VMT15         166      veh-mi
Peak-hour vehicle-miles of travel, VMT60           664      veh-mi
Peak 15-min total travel time, TT15                3.0      veh-h
Capacity from ATS, CdATS                           1700     veh/h
Capacity from PTSF, CdPTSF                         1700     veh/h
Directional Capacity                               2222     veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         2.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      56.0    mi/h
Percent time-spent-following, PTSFd (from above)             57.3
Level of service, LOSd (from above)                          C

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________
```

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	246.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.30
Bicycle LOS	C

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	2/3/1016
Analysis Time Period	Construction Peak Hour
Highway	SR 3(y)
From/To	Carthage to SR 3A
Jurisdiction	NB
Analysis Year	2020
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	4.0	ft	% Trucks and buses	5	%
Lane width	11.0	ft	% Trucks crawling	0.0	%
Segment length	1.4	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	80	%
Up/down	-	%	Access point density	38	/mi

Analysis direction volume, Vd	532	veh/h
Opposing direction volume, Vo	114	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.8	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.990		0.962	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	537	pc/h	119	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	1.7	mi/h
Adj. for access point density,(note-3) fA	9.5	mi/h
Free-flow speed, FFSd	48.8	mi/h
Adjustment for no-passing zones, fnp	2.6	mi/h
Average travel speed, ATSd	41.1	mi/h
Percent Free Flow Speed, PFFS	84.2	%

```
________________________Percent Time-Spent-Following________________________

Direction                            Analysis(d)        Opposing (o)
PCE for trucks, ET                       1.0                1.1
PCE for RVs, ER                          1.0                1.0
Heavy-vehicle adjustment factor, fHV     1.000              0.995
Grade adjustment factor,(note-1) fg      1.00               1.00
Directional flow rate,(note-2) vi        532    pc/h        115     pc/h
Base percent time-spent-following,(note-4) BPTSFd  46.7   %
Adjustment for no-passing zones, fnp              34.7
Percent time-spent-following, PTSFd               75.2   %

_______________Level of Service and Other Performance Measures______________

Level of service, LOS                             D
Volume to capacity ratio, v/c                     0.31
Peak 15-min vehicle-miles of travel, VMT15        186     veh-mi
Peak-hour vehicle-miles of travel, VMT60          745     veh-mi
Peak 15-min total travel time, TT15               4.5     veh-h
Capacity from ATS, CdATS                          1700    veh/h
Capacity from PTSF, CdPTSF                        1700    veh/h
Directional Capacity                              2067    veh/h

____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                        1.4     mi
Length of two-lane highway upstream of the passing lane, Lu -       mi
Length of passing lane including tapers, Lpl                -       mi
Average travel speed, ATSd (from above)                     41.1    mi/h
Percent time-spent-following, PTSFd (from above)            75.2
Level of service, LOSd (from above)                         D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

_______________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________

Posted speed limit, Sp
Percent of segment with occupied on-highway parking      0
Pavement rating, P                                       3
Flow rate in outside lane, vOL                           532.0
Effective width of outside lane, We                      15.00
Effective speed factor, St                               4.79
Bicycle LOS Score, BLOS                                  5.11
Bicycle LOS                                              E

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	Construction Peak Hour
Highway	SR 3(z)
From/To	Just N. of SR 3A
Jurisdiction	EB
Analysis Year	2020
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 3		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	0.6	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	100	%
Up/down	-	%	Access point density	40	/mi

Analysis direction volume, Vd 451 veh/h
Opposing direction volume, Vo 381 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.3	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.990		0.985	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	456	pc/h	387	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	50.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	10.0	mi/h
Free-flow speed, FFSd	40.0	mi/h
Adjustment for no-passing zones, fnp	2.8	mi/h
Average travel speed, ATSd	30.7	mi/h
Percent Free Flow Speed, PFFS	76.7	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		0.995	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	451	pc/h	383	pc/h
Base percent time-spent-following,(note-4) BPTSFd	45.5	%		
Adjustment for no-passing zones, fnp	43.4			
Percent time-spent-following, PTSFd	69.0	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.27	
Peak 15-min vehicle-miles of travel, VMT15	68	veh-mi
Peak-hour vehicle-miles of travel, VMT60	271	veh-mi
Peak 15-min total travel time, TT15	2.2	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3142	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.6	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	30.7	mi/h
Percent time-spent-following, PTSFd (from above)	69.0	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

```
Posted speed limit, Sp                                  45
Percent of segment with occupied on-highway parking     0
Pavement rating, P                                      3
Flow rate in outside lane, vOL                          451.0
Effective width of outside lane, We                     28.00
Effective speed factor, St                              4.42
Bicycle LOS Score, BLOS                                 2.06
Bicycle LOS                                             B

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

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Phone:                                  Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis_______________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/2/2016
Analysis Time Period    Construction Peak Hour
Highway                 SR 26
From/To                 US 11 to 45 Inf Div Dr
Jurisdiction            EB
Analysis Year           2020
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data_________________________________

Highway class  Class 1              Peak hour factor, PHF    1.00
Shoulder width      8.0     ft      % Trucks and buses       5       %
Lane width          12.0    ft      % Trucks crawling        0.0     %
Segment length      2.1     mi      Truck crawl speed        0.0     mi/hr
Terrain type        Level           % Recreational vehicles  0       %
Grade:  Length      -       mi      % No-passing zones       30      %
        Up/down     -       %       Access point density     5       /mi

Analysis direction volume, Vd  391     veh/h
Opposing direction volume, Vo  293     veh/h

____________________________Average Travel Speed______________________________

Direction                              Analysis(d)         Opposing (o)
PCE for trucks, ET                         1.3                 1.4
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV     0.985               0.980
Grade adj. factor,(note-1) fg              1.00                1.00
Directional flow rate,(note-2) vi          397     pc/h        299     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM             -      mi/h
Observed total demand,(note-3) V               -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS            65.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  0.0    mi/h
Adj. for access point density,(note-3) fA     1.3     mi/h

Free-flow speed, FFSd                         63.8    mi/h

Adjustment for no-passing zones, fnp          2.3     mi/h
Average travel speed, ATSd                    56.1    mi/h
Percent Free Flow Speed, PFFS                 88.0    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.995		0.995	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	393	pc/h	294	pc/h
Base percent time-spent-following,(note-4) BPTSFd	40.6	%		
Adjustment for no-passing zones, fnp	37.4			
Percent time-spent-following, PTSFd	62.0	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.23	
Peak 15-min vehicle-miles of travel, VMT15	205	veh-mi
Peak-hour vehicle-miles of travel, VMT60	821	veh-mi
Peak 15-min total travel time, TT15	3.7	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2980	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.1	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	56.1	mi/h
Percent time-spent-following, PTSFd (from above)	62.0	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	391.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	2.16
Bicycle LOS	B

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	ConstructionPeak Hour
Highway	SR 342
From/To	SR 37 to Bush Rd
Jurisdiction	EB
Analysis Year	2020
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.7	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	70	%
Up/down	-	%	Access point density	8	/mi

Analysis direction volume, Vd	904	veh/h
Opposing direction volume, Vo	757	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		0.995	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	904	pc/h	761	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	65.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	2.0	mi/h
Free-flow speed, FFSd	63.0	mi/h
Adjustment for no-passing zones, fnp	1.4	mi/h
Average travel speed, ATSd	48.7	mi/h
Percent Free Flow Speed, PFFS	77.3	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	904	pc/h	757	pc/h
Base percent time-spent-following,(note-4) BPTSFd	72.4	%		
Adjustment for no-passing zones, fnp	22.4			
Percent time-spent-following, PTSFd	84.6	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.53	
Peak 15-min vehicle-miles of travel, VMT15	384	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1537	veh-mi
Peak 15-min total travel time, TT15	7.9	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3123	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	1.7	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	48.7	mi/h
Percent time-spent-following, PTSFd (from above)	84.6	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	904.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	2.58
Bicycle LOS	C

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS 2010: Two-Lane Highways Release 6.1

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	Construction Peak Hour
Highway	US 11
From/To	SR 37 North 2.4 miles
Jurisdiction	EB
Analysis Year	2020
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.4	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	50	%
Up/down	-	%	Access point density	32	/mi

Analysis direction volume, Vd	538	veh/h
Opposing direction volume, Vo	499	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.2	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.990		0.990	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	543	pc/h	504	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	65.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	8.0	mi/h
Free-flow speed, FFSd	57.0	mi/h
Adjustment for no-passing zones, fnp	1.8	mi/h
Average travel speed, ATSd	47.1	mi/h
Percent Free Flow Speed, PFFS	82.6	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	538	pc/h	499	pc/h

Base percent time-spent-following,(note-4) BPTSFd	53.2	%
Adjustment for no-passing zones, fnp	34.6	
Percent time-spent-following, PTSFd	71.2	%

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.34	
Peak 15-min vehicle-miles of travel, VMT15	323	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1291	veh-mi
Peak 15-min total travel time, TT15	6.9	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3084	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.4	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	47.1	mi/h
Percent time-spent-following, PTSFd (from above)	71.2	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	538.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	2.32
Bicycle LOS	B

Notes:

1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Intersection of School Street & SR 3/126 Construction Phase Traffic (Target Year 2020)
Village of Carthage, NY Morning Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	141	175	5	3	298	246	11	18	2	71	2	21
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.989			0.936			0.986			0.963	
Flt Protected	0.950			0.950				0.980			0.967	
Satd. Flow (prot)	1540	1547	0	1540	1292	0	0	1728	0	0	1497	0
Flt Permitted	0.326			0.619				0.874			0.772	
Satd. Flow (perm)	528	1547	0	1003	1292	0	0	1541	0	0	1195	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		8			82			4			34	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.80	0.84	0.31	0.75	0.78	0.86	0.69	0.88	0.50	0.61	0.25	0.45
Heavy Vehicles (%)	2%	3%	40%	2%	6%	6%	2%	2%	2%	14%	2%	14%
Parking (#/hr)					3							
Adj. Flow (vph)	176	208	16	4	382	286	16	20	4	116	8	47
Shared Lane Traffic (%)												
Lane Group Flow (vph)	176	224	0	4	668	0	0	40	0	0	171	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (%)	55.6%	55.6%		55.6%	55.6%		44.4%	44.4%		44.4%	44.4%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	35.3	35.3		35.3	35.3			11.6			11.7	
Actuated g/C Ratio	0.66	0.66		0.66	0.66			0.22			0.22	
v/c Ratio	0.51	0.22		0.01	0.76			0.12			0.60	
Control Delay	17.2	6.8		6.7	18.3			14.8			23.2	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	17.2	6.8		6.7	18.3			14.8			23.2	
LOS	B	A		A	B			B			C	
Approach Delay		11.4			18.2			14.8			23.2	
Approach LOS		B			B			B			C	

Synchro 8 Light Report
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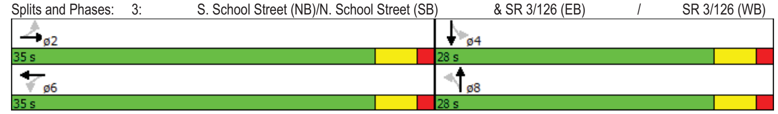
Intersection of School Street & SR 3/126 Construction Phase Traffic (Target Year 2020)
Village of Carthage, NY Morning Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	28	26		1	120			9			37	
Queue Length 95th (ft)	#112	73		4	#324			26			13	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	347	1020		660	878			666			534	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.51	0.22		0.01	0.76			0.06			0.32	

Intersection Summary

Area Type: CBD
Cycle Length: 63
Actuated Cycle Length: 53.6
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 16.6 Intersection LOS: B
Intersection Capacity Utilization 66.8% ICU Level of Service C
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)



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Intersection of School Street & SR 3/126 | Construction Phase Traffic (Target Year 2020)
Village of Carthage, NY | Afternoon Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	53	353	9	2	284	103	10	2	5	304	13	166
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.992			0.958			0.955			0.956	
Flt Protected	0.950			0.950				0.978			0.969	
Satd. Flow (prot)	1510	1608	0	1540	1339	0	0	1670	0	0	1646	0
Flt Permitted	0.402			0.449				0.833			0.784	
Satd. Flow (perm)	639	1608	0	728	1339	0	0	1423	0	0	1332	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		6			43			12			44	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.81	0.93	0.45	0.50	0.88	0.81	0.63	0.25	0.42	0.59	0.50	0.63
Heavy Vehicles (%)	4%	2%	2%	2%	3%	9%	2%	2%	2%	2%	2%	4%
Parking (#/hr)					3							
Adj. Flow (vph)	65	380	20	4	323	127	16	8	12	515	26	263
Shared Lane Traffic (%)												
Lane Group Flow (vph)	65	400	0	4	450	0	0	36	0	0	804	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (%)	55.6%	55.6%		55.6%	55.6%		44.4%	44.4%		44.4%	44.4%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	30.0	30.0		30.0	30.0			23.0			23.0	
Actuated g/C Ratio	0.48	0.48		0.48	0.48			0.37			0.37	
v/c Ratio	0.21	0.52		0.01	0.68			0.07			1.56	
Control Delay	12.0	14.4		9.0	18.0			10.4			284.6	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	12.0	14.4		9.0	18.0			10.4			284.6	
LOS	B	B		A	B			B			F	
Approach Delay		14.0			17.9			10.4			284.6	
Approach LOS		B			B			B			F	

Afternoon Peak-Hour 4:00 pm 4/5/2016 | Synchro 8 Light Report
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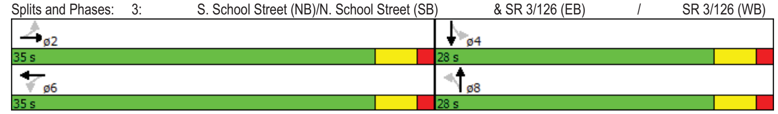
Intersection of School Street & SR 3/126 | Construction Phase Traffic (Target Year 2020)
Village of Carthage, NY | Afternoon Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	14	98		1	113			6			~444	
Queue Length 95th (ft)	32	170		3	203			4			#254	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	304	768		346	660			527			514	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.21	0.52		0.01	0.68			0.07			1.56	

Intersection Summary

Area Type: CBD
Cycle Length: 63
Actuated Cycle Length: 63
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.56
Intersection Signal Delay: 138.6 | Intersection LOS: F
Intersection Capacity Utilization 77.7% | ICU Level of Service D
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)



Afternoon Peak-Hour 4:00 pm 4/5/2016 | Synchro 8 Light Report
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Intersection of School Street & SR 3/126 — Construction Phase Traffic (Target Year 2020)
Village of Carthage, NY — Morning Peak-Hour (Optimum Cycle Length & Existing Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	141	175	5	3	298	246	11	18	2	71	2	21
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.989			0.936			0.986			0.963	
Flt Protected	0.950			0.950				0.980			0.967	
Satd. Flow (prot)	1540	1547	0	1540	1292	0	0	1728	0	0	1497	0
Flt Permitted	0.330			0.619				0.878			0.772	
Satd. Flow (perm)	535	1547	0	1003	1292	0	0	1548	0	0	1195	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		8			82			4			26	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.80	0.84	0.31	0.75	0.78	0.86	0.69	0.88	0.50	0.61	0.25	0.45
Heavy Vehicles (%)	2%	3%	40%	2%	6%	6%	2%	2%	2%	14%	2%	14%
Parking (#/hr)					3							
Adj. Flow (vph)	176	208	16	4	382	286	16	20	4	116	8	47
Shared Lane Traffic (%)												
Lane Group Flow (vph)	176	224	0	4	668	0	0	40	0	0	171	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	47.0	47.0		47.0	47.0		28.0	28.0		28.0	28.0	
Total Split (%)	62.7%	62.7%		62.7%	62.7%		37.3%	37.3%		37.3%	37.3%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	45.7	45.7		45.7	45.7			13.7			13.7	
Actuated g/C Ratio	0.66	0.66		0.66	0.66			0.20			0.20	
v/c Ratio	0.50	0.22		0.01	0.76			0.13			0.67	
Control Delay	14.2	6.2		6.0	16.5			19.8			33.5	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	14.2	6.2		6.0	16.5			19.8			33.5	
LOS	B	A		A	B			B			C	
Approach Delay		9.7			16.4			19.8			33.5	
Approach LOS		A			B			B			C	

Synchro 8 Light Report
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Intersection of School Street & SR 3/126 — Construction Phase Traffic (Target Year 2020)
Village of Carthage, NY — Morning Peak-Hour (Optimum Cycle Length & Existing Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	31	30		1	138			12			53	
Queue Length 95th (ft)	90	72		4	272			32			18	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	351	1020		659	878			517			414	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.50	0.22		0.01	0.76			0.08			0.41	

Intersection Summary

Area Type: CBD
Cycle Length: 75
Actuated Cycle Length: 69.4
Natural Cycle: 75
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.76
Intersection Signal Delay: 16.7 — Intersection LOS: B
Intersection Capacity Utilization 66.8% — ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)

Synchro 8 Light Report
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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	53	353	9	2	284	103	10	2	5	304	13	166
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.992			0.958			0.955			0.956	
Flt Protected	0.950			0.950				0.978			0.969	
Satd. Flow (prot)	1510	1608	0	1540	1339	0	0	1670	0	0	1646	0
Flt Permitted	0.251			0.313				0.767			0.784	
Satd. Flow (perm)	399	1608	0	507	1339	0	0	1310	0	0	1332	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		3			24			12			44	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.81	0.93	0.45	0.50	0.88	0.81	0.63	0.25	0.42	0.59	0.50	0.63
Heavy Vehicles (%)	4%	2%	2%	2%	3%	9%	2%	2%	2%	2%	2%	4%
Parking (#/hr)					3							
Adj. Flow (vph)	65	380	20	4	323	127	16	8	12	515	26	263
Shared Lane Traffic (%)												
Lane Group Flow (vph)	65	400	0	4	450	0	0	36	0	0	804	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	35.0	35.0		35.0	35.0		55.0	55.0		55.0	55.0	
Total Split (%)	38.9%	38.9%		38.9%	38.9%		61.1%	61.1%		61.1%	61.1%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	30.0	30.0		30.0	30.0			50.0			50.0	
Actuated g/C Ratio	0.33	0.33		0.33	0.33			0.56			0.56	
v/c Ratio	0.49	0.74		0.02	0.97			0.05			1.06	
Control Delay	38.8	36.4		21.0	66.1			7.1			70.8	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	38.8	36.4		21.0	66.1			7.1			70.8	
LOS	D	D		C	E			A			E	
Approach Delay		36.8			65.7			7.1			70.8	
Approach LOS		D			E			A			E	

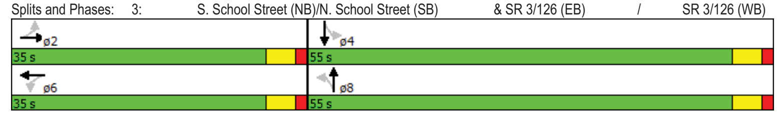
Intersection of School Street & SR 3/126
Village of Carthage, NY
Construction Phase Traffic (Target Year 2020)
Afternoon Peak-Hour (Optimum Cycle Length & Existing Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	29	198		2	239			6			~496	
Queue Length 95th (ft)	65	#318		5	#422			3			200	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	133	538		169	462			733			759	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.49	0.74		0.02	0.97			0.05			1.06	

Intersection Summary

Area Type: CBD
Cycle Length: 90
Actuated Cycle Length: 90
Natural Cycle: 90
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.06
Intersection Signal Delay: 59.2 Intersection LOS: E
Intersection Capacity Utilization 77.7% ICU Level of Service D
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)



HCS Analysis Results

Operations Traffic Condition

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Phone:                                   Fax:
E-Mail:

_________________Directional Two-Lane Highway Segment Analysis________________

Analyst                  Kevin Harder
Agency/Co.               B&V
Date Performed           3/2/2016
Analysis Time Period     Operation Peak Hour
Highway                  SR 3(x)
From/To                  SR 3A to Carthage
Jurisdiction
Analysis Year            2022
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data__________________________________

Highway class  Class 1              Peak hour factor, PHF     1.00
Shoulder width       8.0     ft     % Trucks and buses        9       %
Lane width           12.0    ft     % Trucks crawling         0.0     %
Segment length       2.7     mi     Truck crawl speed         0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones        50      %
        Up/down      -       %      Access point density      17      /mi

Analysis direction volume, Vd  230     veh/h
Opposing direction volume, Vo  83      veh/h

____________________________Average Travel Speed______________________________

Direction                              Analysis(d)        Opposing (o)
PCE for trucks, ET                         1.5                 1.9
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV     0.957               0.925
Grade adj. factor,(note-1) fg              1.00                1.00
Directional flow rate,(note-2) vi          240     pc/h        90      pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM                 -      mi/h
Observed total demand,(note-3) V                   -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS                65.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS    0.0     mi/h
Adj. for access point density,(note-3) fA        4.3     mi/h

Free-flow speed, FFSd                             60.8    mi/h

Adjustment for no-passing zones, fnp              2.2     mi/h
Average travel speed, ATSd                        56.0    mi/h
Percent Free Flow Speed, PFFS                     92.2    %
```

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.991		0.991	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	232	pc/h	84	pc/h
Base percent time-spent-following,(note-4) BPTSFd	24.5	%		
Adjustment for no-passing zones, fnp	41.8			
Percent time-spent-following, PTSFd	55.2	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.14	
Peak 15-min vehicle-miles of travel, VMT15	155	veh-mi
Peak-hour vehicle-miles of travel, VMT60	621	veh-mi
Peak 15-min total travel time, TT15	2.8	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2337	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.7	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	56.0	mi/h
Percent time-spent-following, PTSFd (from above)	55.2	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	230.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	3.26
Bicycle LOS	C

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	Operation Peak Hour
Highway	SR 3(y)
From/To	Carthage to SR 3A
Jurisdiction	NB
Analysis Year	2022
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	4.0	ft	% Trucks and buses	4	%
Lane width	11.0	ft	% Trucks crawling	0.0	%
Segment length	1.4	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	80	%
Up/down	-	%	Access point density	38	/mi

Analysis direction volume, Vd 471 veh/h
Opposing direction volume, Vo 140 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.7	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.992		0.973	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	475	pc/h	144	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	60.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	1.7	mi/h
Adj. for access point density,(note-3) fA	9.5	mi/h
Free-flow speed, FFSd	48.8	mi/h
Adjustment for no-passing zones, fnp	3.0	mi/h
Average travel speed, ATSd	41.0	mi/h
Percent Free Flow Speed, PFFS	84.0	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		0.996	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	471	pc/h	141	pc/h
Base percent time-spent-following,(note-4) BPTSFd	42.8	%		
Adjustment for no-passing zones, fnp	40.3			
Percent time-spent-following, PTSFd	73.8	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.28	
Peak 15-min vehicle-miles of travel, VMT15	165	veh-mi
Peak-hour vehicle-miles of travel, VMT60	659	veh-mi
Peak 15-min total travel time, TT15	4.0	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2208	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	1.4	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	41.0	mi/h
Percent time-spent-following, PTSFd (from above)	73.8	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

```
Posted speed limit, Sp
Percent of segment with occupied on-highway parking       0
Pavement rating, P                                        3
Flow rate in outside lane, vOL                            471.0
Effective width of outside lane, We                       15.00
Effective speed factor, St                                4.79
Bicycle LOS Score, BLOS                                   4.76
Bicycle LOS                                               E

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
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Phone:                                   Fax:
E-Mail:

________________Directional Two-Lane Highway Segment Analysis_______________

Analyst                 Kevin Harder
Agency/Co.              B&V
Date Performed          3/2/2016
Analysis Time Period    Operation Peak Hour
Highway                 SR 3(z)
From/To                 Just N. of SR 3A
Jurisdiction            EB
Analysis Year           2022
Description  FTD Regional Roads - CIS EIS

__________________________________Input Data_________________________________

Highway class  Class 3              Peak hour factor, PHF    1.00
Shoulder width       8.0     ft     % Trucks and buses       4       %
Lane width           12.0    ft     % Trucks crawling        0.0     %
Segment length       0.6     mi     Truck crawl speed        0.0     mi/hr
Terrain type         Level          % Recreational vehicles  0       %
Grade:  Length       -       mi     % No-passing zones       100     %
        Up/down      -       %      Access point density     40      /mi

Analysis direction volume, Vd  326     veh/h
Opposing direction volume, Vo  430     veh/h

____________________________Average Travel Speed______________________________

Direction                             Analysis(d)         Opposing (o)
PCE for trucks, ET                        1.4                 1.3
PCE for RVs, ER                           1.0                 1.0
Heavy-vehicle adj. factor,(note-5) fHV    0.984               0.988
Grade adj. factor,(note-1) fg             1.00                1.00
Directional flow rate,(note-2) vi         331     pc/h        435     pc/h

Free-Flow Speed from Field Measurement:
Field measured speed,(note-3) S FM              -      mi/h
Observed total demand,(note-3) V                -      veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS             50.0    mi/h
Adj. for lane and shoulder width,(note-3) fLS  0.0     mi/h
Adj. for access point density,(note-3) fA      10.0    mi/h

Free-flow speed, FFSd                          40.0    mi/h

Adjustment for no-passing zones, fnp           2.5     mi/h
Average travel speed, ATSd                     31.5    mi/h
Percent Free Flow Speed, PFFS                  78.8    %
```

Percent Time-Spent-Following				
Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.996		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	327	pc/h	430	pc/h
Base percent time-spent-following,(note-4) BPTSFd	38.1	%		
Adjustment for no-passing zones, fnp	45.6			
Percent time-spent-following, PTSFd	57.8	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.26	
Peak 15-min vehicle-miles of travel, VMT15	49	veh-mi
Peak-hour vehicle-miles of travel, VMT60	196	veh-mi
Peak 15-min total travel time, TT15	1.6	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	2993	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	0.6	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	31.5	mi/h
Percent time-spent-following, PTSFd (from above)	57.8	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	326.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	1.62
Bicycle LOS	B

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	Operation Peak Hour
Highway	SR 26
From/To	US 11 to 45 Inf Div Dr
Jurisdiction	EB
Analysis Year	2022
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 1		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.1	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	30	%
Up/down	-	%	Access point density	5	/mi

Analysis direction volume, Vd	358	veh/h
Opposing direction volume, Vo	312	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.3		1.4	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.985		0.980	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	363	pc/h	318	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	65.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	1.3	mi/h
Free-flow speed, FFSd	63.8	mi/h
Adjustment for no-passing zones, fnp	2.2	mi/h
Average travel speed, ATSd	56.3	mi/h
Percent Free Flow Speed, PFFS	88.3	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.1		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.995		0.995	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	360	pc/h	314	pc/h
Base percent time-spent-following,(note-4) BPTSFd	38.9	%		
Adjustment for no-passing zones, fnp	39.5			
Percent time-spent-following, PTSFd	60.0	%		

Level of Service and Other Performance Measures

Level of service, LOS	C	
Volume to capacity ratio, v/c	0.21	
Peak 15-min vehicle-miles of travel, VMT15	188	veh-mi
Peak-hour vehicle-miles of travel, VMT60	752	veh-mi
Peak 15-min total travel time, TT15	3.3	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3189	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.1	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	56.3	mi/h
Percent time-spent-following, PTSFd (from above)	60.0	
Level of service, LOSd (from above)	C	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

Posted speed limit, Sp	55
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	358.0
Effective width of outside lane, We	28.00
Effective speed factor, St	4.79
Bicycle LOS Score, BLOS	2.11
Bicycle LOS	B

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS 2010: Two-Lane Highways Release 6.1

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	Operation Peak Hour
Highway	SR 342
From/To	SR 37 to Bush Rd
Jurisdiction	EB
Analysis Year	2022
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	1.7	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	70	%
Up/down	-	%	Access point density	8	/mi

Analysis direction volume, Vd	861	veh/h
Opposing direction volume, Vo	793	veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.1	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	1.000		0.995	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	861	pc/h	797	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	65.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	2.0	mi/h
Free-flow speed, FFSd	63.0	mi/h
Adjustment for no-passing zones, fnp	1.3	mi/h
Average travel speed, ATSd	48.9	mi/h
Percent Free Flow Speed, PFFS	77.6	%

```
_________________________Percent Time-Spent-Following_________________________

Direction                              Analysis(d)        Opposing (o)
PCE for trucks, ET                         1.0                 1.0
PCE for RVs, ER                            1.0                 1.0
Heavy-vehicle adjustment factor, fHV       1.000               1.000
Grade adjustment factor,(note-1) fg        1.00                1.00
Directional flow rate,(note-2) vi          861    pc/h         793     pc/h
Base percent time-spent-following,(note-4) BPTSFd  71.7   %
Adjustment for no-passing zones, fnp               22.8
Percent time-spent-following, PTSFd                83.6   %

________________Level of Service and Other Performance Measures_______________

Level of service, LOS                              D
Volume to capacity ratio, v/c                      0.54
Peak 15-min vehicle-miles of travel, VMT15         366     veh-mi
Peak-hour vehicle-miles of travel, VMT60           1464    veh-mi
Peak 15-min total travel time, TT15                7.5     veh-h
Capacity from ATS, CdATS                           1700    veh/h
Capacity from PTSF, CdPTSF                         1700    veh/h
Directional Capacity                               3073    veh/h

_____________________________Passing Lane Analysis____________________________

Total length of analysis segment, Lt                         1.7     mi
Length of two-lane highway upstream of the passing lane, Lu  -       mi
Length of passing lane including tapers, Lpl                 -       mi
Average travel speed, ATSd (from above)                      48.9    mi/h
Percent time-spent-following, PTSFd (from above)             83.6
Level of service, LOSd (from above)                          D

___________________Average Travel Speed  with Passing Lane____________________

Downstream length of two-lane highway within effective
    length of passing lane for average travel speed, Lde     -       mi
Length of two-lane highway downstream of effective
    length of the passing lane for average travel speed, Ld  -       mi
Adj. factor for the effect of passing lane
    on average speed, fpl                                    -
Average travel speed including passing lane, ATSpl           -

________________Percent Time-Spent-Following with Passing Lane________________

Downstream length of two-lane highway within effective length
    of passing lane for percent time-spent-following, Lde    -       mi
Length of two-lane highway downstream of effective length of
    the passing lane for percent time-spent-following, Ld    -       mi
Adj. factor for the effect of passing lane
    on percent time-spent-following, fpl                     -
Percent time-spent-following
    including passing lane, PTSFpl                           -       %

______Level of Service and Other Performance Measures with Passing Lane ______

Level of service including passing lane, LOSpl     -
Peak 15-min total travel time, TT15                -       veh-h

__________________________ Bicycle Level of Service __________________________

Posted speed limit, Sp                                          55
Percent of segment with occupied on-highway parking             0
Pavement rating, P                                              3
Flow rate in outside lane, vOL                                  861.0
Effective width of outside lane, We                             28.00
Effective speed factor, St                                      4.79
Bicycle LOS Score, BLOS                                         2.56
Bicycle LOS                                                     C

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain
   is one of the base conditions. For the purpose of grade adjustment, specific
   dewngrade segments are treated as level terrain.
2. If vi (vd or vo ) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a
   specific downgrade.
```

HCS 2010: Two-Lane Highways Release 6.1

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst	Kevin Harder
Agency/Co.	B&V
Date Performed	3/2/2016
Analysis Time Period	Operation Peak Hour
Highway	US 11
From/To	SR 37 North 2.4 miles
Jurisdiction	EB
Analysis Year	2022
Description	FTD Regional Roads - CIS EIS

Input Data

Highway class	Class 2		Peak hour factor, PHF	1.00	
Shoulder width	8.0	ft	% Trucks and buses	5	%
Lane width	12.0	ft	% Trucks crawling	0.0	%
Segment length	2.4	mi	Truck crawl speed	0.0	mi/hr
Terrain type	Level		% Recreational vehicles	0	%
Grade: Length	-	mi	% No-passing zones	50	%
Up/down	-	%	Access point density	32	/mi

Analysis direction volume, Vd 532 veh/h
Opposing direction volume, Vo 514 veh/h

Average Travel Speed

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.2		1.2	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adj. factor,(note-5) fHV	0.990		0.990	
Grade adj. factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	537	pc/h	519	pc/h

Free-Flow Speed from Field Measurement:		
Field measured speed,(note-3) S FM	-	mi/h
Observed total demand,(note-3) V	-	veh/h
Estimated Free-Flow Speed:		
Base free-flow speed,(note-3) BFFS	65.0	mi/h
Adj. for lane and shoulder width,(note-3) fLS	0.0	mi/h
Adj. for access point density,(note-3) fA	8.0	mi/h
Free-flow speed, FFSd	57.0	mi/h
Adjustment for no-passing zones, fnp	1.7	mi/h
Average travel speed, ATSd	47.1	mi/h
Percent Free Flow Speed, PFFS	82.6	%

Percent Time-Spent-Following

Direction	Analysis(d)		Opposing (o)	
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	1.000		1.000	
Grade adjustment factor,(note-1) fg	1.00		1.00	
Directional flow rate,(note-2) vi	532	pc/h	514	pc/h
Base percent time-spent-following,(note-4) BPTSFd	53.3	%		
Adjustment for no-passing zones, fnp	34.8			
Percent time-spent-following, PTSFd	71.0	%		

Level of Service and Other Performance Measures

Level of service, LOS	D	
Volume to capacity ratio, v/c	0.33	
Peak 15-min vehicle-miles of travel, VMT15	319	veh-mi
Peak-hour vehicle-miles of travel, VMT60	1277	veh-mi
Peak 15-min total travel time, TT15	6.8	veh-h
Capacity from ATS, CdATS	1700	veh/h
Capacity from PTSF, CdPTSF	1700	veh/h
Directional Capacity	3145	veh/h

Passing Lane Analysis

Total length of analysis segment, Lt	2.4	mi
Length of two-lane highway upstream of the passing lane, Lu	-	mi
Length of passing lane including tapers, Lpl	-	mi
Average travel speed, ATSd (from above)	47.1	mi/h
Percent time-spent-following, PTSFd (from above)	71.0	
Level of service, LOSd (from above)	D	

Average Travel Speed with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld	-	mi
Adj. factor for the effect of passing lane on average speed, fpl	-	
Average travel speed including passing lane, ATSpl	-	

Percent Time-Spent-Following with Passing Lane

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde	-	mi
Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld	-	mi
Adj. factor for the effect of passing lane on percent time-spent-following, fpl	-	
Percent time-spent-following including passing lane, PTSFpl	-	%

Level of Service and Other Performance Measures with Passing Lane

Level of service including passing lane, LOSpl	-	
Peak 15-min total travel time, TT15	-	veh-h

Bicycle Level of Service

```
Posted speed limit, Sp                                      55
Percent of segment with occupied on-highway parking         0
Pavement rating, P                                          3
Flow rate in outside lane, vOL                              532.0
Effective width of outside lane, We                         28.00
Effective speed factor, St                                  4.79
Bicycle LOS Score, BLOS                                     2.31
Bicycle LOS                                                 B
```

Notes:
1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only.
5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Intersection of School Street & SR 3/126 — Operation Phase Traffic (Target Year 2022)
Village of Carthage, NY — Morning Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	98	178	5	3	304	231	12	14	2	80	3	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.989			0.939			0.985			0.949	
Flt Protected	0.950			0.950				0.978			0.972	
Satd. Flow (prot)	1540	1548	0	1540	1296	0	0	1723	0	0	1554	0
Flt Permitted	0.310			0.616				0.857			0.803	
Satd. Flow (perm)	502	1548	0	998	1296	0	0	1510	0	0	1284	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		8			75			4			55	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.80	0.84	0.31	0.75	0.78	0.86	0.69	0.88	0.50	0.61	0.25	0.45
Heavy Vehicles (%)	2%	3%	40%	2%	6%	6%	2%	2%	2%	11%	2%	5%
Parking (#/hr)					3							
Adj. Flow (vph)	122	212	16	4	390	269	17	16	4	131	12	87
Shared Lane Traffic (%)												
Lane Group Flow (vph)	122	228	0	4	659	0	0	37	0	0	230	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (%)	55.6%	55.6%		55.6%	55.6%		44.4%	44.4%		44.4%	44.4%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	32.9	32.9		32.9	32.9			13.0			13.0	
Actuated g/C Ratio	0.59	0.59		0.59	0.59			0.23			0.23	
v/c Ratio	0.41	0.25		0.01	0.83			0.10			0.68	
Control Delay	14.0	7.5		7.0	23.0			14.1			24.1	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	14.0	7.5		7.0	23.0			14.1			24.1	
LOS	B	A		A	C			B			C	
Approach Delay		9.8			22.9			14.1			24.1	
Approach LOS		A			C			B			C	

Synchro 8 Light Report
Page 1

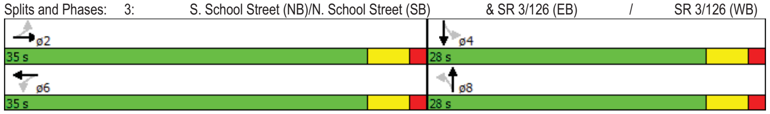
Intersection of School Street & SR 3/126 — Operation Phase Traffic (Target Year 2022)
Village of Carthage, NY — Morning Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	19	29		1	130			8			48	
Queue Length 95th (ft)	61	76		4	#323			24			13	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	294	913		586	792			626			563	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.41	0.25		0.01	0.83			0.06			0.41	

Intersection Summary

Area Type: CBD
Cycle Length: 63
Actuated Cycle Length: 56
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.83
Intersection Signal Delay: 19.3 Intersection LOS: B
Intersection Capacity Utilization 64.1% ICU Level of Service C
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)



Intersection of School Street & SR 3/126 — Operation Phase Traffic (Target Year 2022)
Village of Carthage, NY — Afternoon Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	359	10	2	289	113	11	3	5	289	9	123
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.992			0.955			0.960			0.963	
Flt Protected	0.950			0.950				0.980			0.966	
Satd. Flow (prot)	1540	1608	0	1540	1341	0	0	1682	0	0	1655	0
Flt Permitted	0.386			0.441				0.833			0.767	
Satd. Flow (perm)	626	1608	0	715	1341	0	0	1430	0	0	1314	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		6			47			12			35	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.81	0.93	0.45	0.50	0.88	0.81	0.63	0.25	0.42	0.59	0.50	0.63
Heavy Vehicles (%)	2%	2%	2%	2%	3%	7%	2%	2%	2%	2%	2%	4%
Parking (#/hr)					3							
Adj. Flow (vph)	86	386	22	4	328	140	17	12	12	490	18	195
Shared Lane Traffic (%)												
Lane Group Flow (vph)	86	408	0	4	468	0	0	41	0	0	703	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (%)	55.6%	55.6%		55.6%	55.6%		44.4%	44.4%		44.4%	44.4%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	30.0	30.0		30.0	30.0			23.0			23.0	
Actuated g/C Ratio	0.48	0.48		0.48	0.48			0.37			0.37	
v/c Ratio	0.29	0.53		0.01	0.71			0.08			1.40	
Control Delay	13.4	14.6		9.0	18.9			10.8			215.2	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	13.4	14.6		9.0	18.9			10.8			215.2	
LOS	B	B		A	B			B			F	
Approach Delay		14.4			18.8			10.8			215.2	
Approach LOS		B			B			B			F	

Intersection of School Street & SR 3/126
Village of Carthage, NY

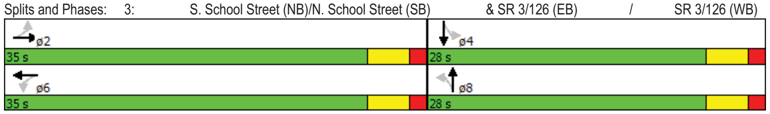
Operation Phase Traffic (Target Year 2022)
Afternoon Peak-Hour (Existing Timing & Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	19	101		1	118			7			~367	
Queue Length 95th (ft)	41	174		3	215			4			#197	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	298	768		340	663			529			501	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.29	0.53		0.01	0.71			0.08			1.40	

Intersection Summary

Area Type: CBD
Cycle Length: 63
Actuated Cycle Length: 63
Natural Cycle: 80
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.40
Intersection Signal Delay: 98.1 Intersection LOS: F
Intersection Capacity Utilization 74.7% ICU Level of Service D
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)



Synchro 8 Light Report
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Intersection of School Street & SR 3/126
Village of Carthage, NY

Operation Phase Traffic (Target Year 2022)
Morning Peak-Hour (Optimum Cycle Length & Existing Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	98	178	5	3	304	231	12	14	2	80	3	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.989			0.939			0.985			0.949	
Flt Protected	0.950			0.950				0.978			0.972	
Satd. Flow (prot)	1540	1548	0	1540	1296	0	0	1723	0	0	1554	0
Flt Permitted	0.318			0.616				0.861			0.803	
Satd. Flow (perm)	515	1548	0	998	1296	0	0	1517	0	0	1284	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		8			75			4			47	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.80	0.84	0.31	0.75	0.78	0.86	0.69	0.88	0.50	0.61	0.25	0.45
Heavy Vehicles (%)	2%	3%	40%	2%	6%	6%	2%	2%	2%	11%	2%	5%
Parking (#/hr)					3							
Adj. Flow (vph)	122	212	16	4	390	269	17	16	4	131	12	87
Shared Lane Traffic (%)												
Lane Group Flow (vph)	122	228	0	4	659	0	0	37	0	0	230	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	42.0	42.0		42.0	42.0		28.0	28.0		28.0	28.0	
Total Split (%)	60.0%	60.0%		60.0%	60.0%		40.0%	40.0%		40.0%	40.0%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	39.6	39.6		39.6	39.6			14.6			14.6	
Actuated g/C Ratio	0.62	0.62		0.62	0.62			0.23			0.23	
v/c Ratio	0.38	0.24		0.01	0.80			0.11			0.70	
Control Delay	12.8	7.4		7.0	19.9			16.8			29.1	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	12.8	7.4		7.0	19.9			16.8			29.1	
LOS	B	A		A	B			B			C	
Approach Delay		9.3			19.8			16.8			29.1	
Approach LOS		A			B			B			C	

Synchro 8 Light Report
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Operation Phase Traffic (Target Year 2022)
Morning Peak-Hour (Optimum Cycle Length & Existing Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	20	32		1	142			10			61	
Queue Length 95th (ft)	62	79		4	#340			28			16	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	317	958		615	828			548			492	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.38	0.24		0.01	0.80			0.07			0.47	

Intersection Summary

Area Type: CBD
Cycle Length: 70
Actuated Cycle Length: 64.2
Natural Cycle: 70
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.80
Intersection Signal Delay: 18.5 Intersection LOS: B
Intersection Capacity Utilization 64.1% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)

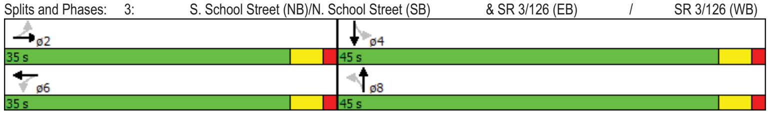
Operation Phase Traffic (Target Year 2022)
Afternoon Peak-Hour (Optimum Cycle Length & Existing Phasing)

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	70	359	10	2	289	113	11	3	5	289	9	123
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	14	14	14	14	14	14
Storage Length (ft)	89		0	89		0	0		0	0		0
Storage Lanes	1		0	1		0	0		0	0		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.992			0.955			0.960			0.963	
Flt Protected	0.950			0.950				0.980			0.966	
Satd. Flow (prot)	1540	1608	0	1540	1341	0	0	1682	0	0	1655	0
Flt Permitted	0.287			0.354				0.787			0.767	
Satd. Flow (perm)	465	1608	0	574	1341	0	0	1351	0	0	1314	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		4			31			12			35	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		483			507			530			440	
Travel Time (s)		11.0			11.5			12.0			10.0	
Peak Hour Factor	0.81	0.93	0.45	0.50	0.88	0.81	0.63	0.25	0.42	0.59	0.50	0.63
Heavy Vehicles (%)	2%	2%	2%	2%	3%	7%	2%	2%	2%	2%	2%	4%
Parking (#/hr)					3							
Adj. Flow (vph)	86	386	22	4	328	140	17	12	12	490	18	195
Shared Lane Traffic (%)												
Lane Group Flow (vph)	86	408	0	4	468	0	0	41	0	0	703	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Detector Phase	2	2		6	6		8	8		4	4	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Minimum Split (s)	35.0	35.0		35.0	35.0		28.0	28.0		28.0	28.0	
Total Split (s)	35.0	35.0		35.0	35.0		45.0	45.0		45.0	45.0	
Total Split (%)	43.8%	43.8%		43.8%	43.8%		56.3%	56.3%		56.3%	56.3%	
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0			0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		Max	Max		None	None		None	None	
Act Effct Green (s)	30.0	30.0		30.0	30.0			40.0			40.0	
Actuated g/C Ratio	0.38	0.38		0.38	0.38			0.50			0.50	
v/c Ratio	0.49	0.67		0.02	0.90			0.06			1.04	
Control Delay	31.1	27.4		16.0	44.9			8.4			68.2	
Queue Delay	0.0	0.0		0.0	0.0			0.0			0.0	
Total Delay	31.1	27.4		16.0	44.9			8.4			68.2	
LOS	C	C		B	D			A			E	
Approach Delay		28.0			44.6			8.4			68.2	
Approach LOS		C			D			A			E	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Queue Length 50th (ft)	32	165		1	203			7			~377	
Queue Length 95th (ft)	69	267		4	#373			4			174	
Internal Link Dist (ft)		403			427			450			360	
Turn Bay Length (ft)	89			89								
Base Capacity (vph)	174	605		215	522			681			674	
Starvation Cap Reductn	0	0		0	0			0			0	
Spillback Cap Reductn	0	0		0	0			0			0	
Storage Cap Reductn	0	0		0	0			0			0	
Reduced v/c Ratio	0.49	0.67		0.02	0.90			0.06			1.04	

Intersection Summary	
Area Type: CBD	
Cycle Length: 80	
Actuated Cycle Length: 80	
Natural Cycle: 80	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.04	
Intersection Signal Delay: 48.7	Intersection LOS: D
Intersection Capacity Utilization 74.7%	ICU Level of Service D
Analysis Period (min) 15	
~ Volume exceeds capacity, queue is theoretically infinite.	
Queue shown is maximum after two cycles.	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 3: S. School Street (NB)/N. School Street (SB) & SR 3/126 (EB) / SR 3/126 (WB)



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