2008

CHART

NCDP

Non-Constrained Deployment Plan

SHA State Highway Administration
Maryland Department of Transportation

Office of CHART and ITS Development
State Highway Administration
7491 Connelley Drive
Hanover, MD 21076 -1701
(800) 543-2515
www.chart.state.md.us

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Preface & Executive Summary

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This report was developed and finalized in December of 2008 by the Maryland State Highway Administration Office of CHART, Division of ITS Development; with support from Telvent Transportation North America.

Preface

The following scenario is a visionary look into how the Coordinated Highways Action Response Team (CHART) program can eventually operate and manage Maryland's highway system. The scenario takes place in the not-too-distant future – a future that will be attainable as CHART builds upon its successes over the past 15 years using strategies outlined within this document.

The main character is a typical Maryland commuter, whose day will turn out differently than a present day commuter as a result of the technologies and services provided by CHART. While it is unlikely that all of the incidents outlined in the following scenario could occur in a single day for most Maryland residents, the scenario aims to portray the potential of the CHART program impacting the lives and day-to-day travel of Maryland citizens beyond the many benefits it already provides.

6:30 AM

A Maryland Commuter who lives in Frederick wakes up to begin her daily weekday routine on the Friday before a three-day holiday weekend. Already on her mind, however, is the important client presentation she has in Baltimore in the afternoon, and how much she needs to get done in the office beforehand. Also on her mind is the family vacation awaiting her over the extended weekend.

7:45 AM

She gets the kids up and off to school before she hurries out the door for work by 7:45 AM. She checks her cell phone as the garage door opens to see what her commute looks like this morning.

The service for which the Commuter recently registered provides personalized travel information for her commute routes between Frederick and Northern Bethesda. The service sends text messages to her phone alerting her of news regarding accidents, construction, bad weather, or congestion occurring along her route to work.

CHART Strategy 3.16.2 *Provide Data to support "Personal Subscription Services" for Traveler Information*

In the CHART Statewide Operations Center (SOC) in Hanover, MD, operators closely watch traffic conditions in anticipation of holiday travel. The traffic simulation system is forecasting heavy traffic to begin 30 minutes before normal this morning, specifically along major Interstates. Commuters are leaving for the office early so they can get a head start on the holiday weekend by leaving work a little earlier in the afternoon. The CHART operators utilize an automated traffic management system to disseminate information to travelers so that traffic delays are lowered to more acceptable levels.

CHART Strategy 5.16.1 *Develop Software to Provide Transportation Network Simulation and Prediction Capabilities*

CHART Strategy 5.16.7 *Develop CHART Operator Decision Support*

7:55 AM	Our Commuter is on her way to work, on I-270 just South of Frederick, when she hears her cell phone alert. "Great," she thinks, "what's in store for me now?" She flips open the phone to read: HEAVY TRAFFIC ON I-270 SB ROUTE, DELAY ESTIMATED AT 25 MINUTES, CONSIDER ALTERNATE ROUTE "That's 10 minutes more than usual," she thinks before realizing it must be due to the upcoming holiday. "I'm going to see how it looks ahead before I get off the interstate," she decides.	CHART Strategy 3.16.3 *Exchange/Integrate Multi-modal Data with/from Private Information Service Providers (ISPs)*
8:00 AM	*CHART operators are now busy coordinating with several county traffic operations centers- to give sufficient green traffic signal time to the estimated number of vehicles that will soon be diverted from the interstate.*	CHART Strategy 4.16.1 *Integrate Arterial Traffic Management Data* CHART Strategy 5.10.1 *Integrate Traffic Signal System Data*
8:10 AM	Our Commuter reaches the I-270 southbound overhead electronic message sign at Exit 13, on which she frequently relies for traffic information. The sign reads: TRAVEL TIME TO I-495 37 MINUTES, CONSIDER MD 355 ALTERNATIVE She decides to take the advice and exits onto the alternative route. Even though our Commuter recognizes that a large portion of traffic is doing the same, she is unaware of the level of coordination that is taking place to get traffic off the Interstate exit ramp and through the MD 355 corridor.	CHART Strategy 3.9.1 *Additional Dynamic Message Signs (DMS)*
8:50 AM	Despite the heavy congestion, the Commuter arrives to work on time, having been delayed a total of 20 minutes – within the window for which she typically plans. Relieved that she didn't lose any of her much-needed preparation time, she begins to get ready for the client presentation in Baltimore at 1:00 PM.	
10:50 AM	*The CHART incident detection system has identified a probable accident on northbound I-95, just north of MD 198, between Washington D.C. and Baltimore. CHART operators use roadside cameras to verify the accident. They also use the images to start coordinating with the most appropriate public safety agencies and other resources to remove the vehicles involved so normal traffic flow can be restored as quickly as possible. The CHART system disseminates information about the incident to a variety of agencies and information outlets.*	CHART Strategy 1.1.1 *Additional Closed Circuit Television (CCTV)* CHART Strategy 2.16.7 *Multi-modal Incident/Emergency Information Clearinghouse*

11:15 AM	Our Commuter is already slightly behind schedule to depart for Baltimore, but checks the CHART web site for current information on traffic and construction. She understands that three minutes spent checking road conditions now may save her 15 minutes or more of travel time.	CHART Strategy 3.8.1 *CHART Web Site Enhancements/Development*
	She sees there is a three-car accident on northbound I-95, and the traffic flow map shows that traffic is slow approaching the accident location.	
	The commuter logs into the CHART website with her user-ID, allowing her to easily click on her origin as "work" and then enter her destination address for the meeting. The CHART system calculates the fastest route based on current transportation conditions. The preferred route is shown as the Baltimore-Washington (B-W) Parkway, which would bypass the I-95 accident scene and growing backup – resulting in a 75-minute travel estimate. The second option is to use the MARC train departing at 11:45 from Greenbelt – estimated at 85 minutes; the third being to brave I-95, which is estimated at 95 minutes.	CHART Strategy 3.16.5 *Develop Traveler Information Software* CHART Strategy 3.16.1 *Multi-modal Traveler Information Data Repository/Clearinghouse*
	Taking the train would get her to the meeting on time and allow her to prepare while on the train, but she would have to come back to the Park-n-Ride to get her car rather than driving directly home from Baltimore to get a head start on the holiday weekend traffic. She decides to try driving the B-W Parkway. Knowing that conditions may change by the time she reaches the exit to use the MARC or I-95, she requests to be paged on her cell phone if they become better than the B-W Parkway option.	
11:30 AM	On her way, our Commuter receives the page she had worried about – the CHART website had now calculated that travel time along the B-W Parkway was exceeding the 85 minutes it would take to use MARC.	
	"Everyone's using the Parkway," she realizes, "I'm not going to get there in time to prepare." She decides that taking the train will be the only way to adequately prepare for this important client presentation, even though it means the family will have to leave later than expected.	
	Just to be sure, she calls 511 Traveler Information from her cell phone to double check on the MARC train schedule and status to see if it's running on time, which it is. Approaching the Greenbelt exit off the Beltway, she also checks the roadside message sign to ensure the Park-n-Ride lot has spaces available.	CHART Strategy 5.8.1 *Statewide 511 Service* CHART Strategy 4.12.1 *Support for Deployment of Traffic Management Infrastructure at Inter-modal Transfer Points and Major Parking Facilities*
	"Well, at least I'll have plenty of time on the train to get ready for this meeting . . . and call my husband to let him know I'll be getting home late," she realizes.	
12:55 PM	Having a relaxing, yet productive, train ride, our Commuter arrives at her 1:00 pm Baltimore meeting on time and well prepared.	

3:45 PM	After a good meeting and upon returning to Greenbelt, the Commuter checks the status of her route home using a traffic flow map displayed on a CHART traveler information board at the Park-n-Ride center. She sees that her "back roads" route will be better right now because of the early congestion levels. She is hoping that she will not arrive home too late, as holiday traffic to the beach will be heavy and travel time could be lengthy.	CHART Strategy 3.8.4 *Electronic Traveler Information Board* CHART Strategy 1.2.1 *Additional Roadside Traffic Detectors*
5:00 PM	*CHART is busy with the combined holiday and commute rush. The dynamic toll lane fares have been upped to maximum levels along major Interstates, and coordination between CHART and multiple other transportation organizations is at a peak.*	CHART Strategy 4.11.7 *Support Deployment of Dynamic Toll Lanes*
5:30 PM	The Commuter arrives home by 5:30 pm and helps her husband pack the kids into the family car to leave for Ocean City by 6:00. She is relieved to hear her husband has already checked and confirmed their preferred travel route with their minivan's in-vehicle route guidance subscription service from the family home computer.	
6:30 PM	The family – just under way – hits heavy traffic in Gaithersburg. The route-guidance system helps by directing them along roads where current delay levels are minimal.	CHART Strategy 3.16.3 *Exchange/Integrate Multi-modal Data with/from Private Information Service Providers (ISPs)*
7:10 PM	The in-vehicle route-guidance device indicates traffic conditions are still heavy along US 50 heading east and that HOT lanes are currently charging the highest level toll. Nonetheless, they decide to use the toll lanes. While they will pay extra due to the holiday and traffic volumes, the route-guidance system reports an estimated 25 minutes saved in travel to Ocean City.	CHART Strategy 3.16.1 *Multi-modal Traveler Information Data Repository/Clearinghouse*
8:00 PM	Using the toll lanes allows the Commuter and her family to make good time, but, as if the day has not been hectic enough, a tire goes flat on their van along US 50, just east of the Bay Bridge. They call #77 from their cell phone to request assistance because they do not feel safe changing the tire on the roadway shoulder. Other cars have been slowing down to avoid the family van, and this slowdown is beginning to cause a backup. Within 10 minutes, the family sees a CHART Emergency Traffic Patrol (ETP) vehicle approaching with flashing safety lights and a traffic arrow panel mounted on the rear. The ETP responders help with the tire change, which restores traffic flow to normal conditions and enables the family to proceed much more quickly and safely than they otherwise would have.	CHART Strategy 2.16.5 *Integrate Incident Location Data from Wireless Enhanced 911 and #77 Systems* CHART Strategy 2.5.4 *Extend CHART Traffic Patrol*
11:00 PM	The Commuter and her family arrive safely at their vacation destination, and are pleased with their travel time considering the heavy traffic and flat tire. They look forward to a full three-day weekend.	

Executive Summary

The Coordinated Highways Action Response Team (CHART) is Maryland's highway operations element for the state's Intelligent Transportation Systems (ITS) program. The program is a joint effort of the Maryland Department of Transportation (MDOT), Maryland State Highway Administration (MDSHA), Maryland Transportation Authority (MdTA), and the Maryland State Police (MSP), in cooperation with federal, other state, and local agencies.

CHART began in the mid-1980s as the "Reach the Beach" initiative focused on improving travel to and from Maryland's eastern shore. As a result of its success, CHART is now a multi-discipline program with activities focusing on the Baltimore-Washington-Frederick-Annapolis corridors, but also extending statewide. CHART's mission was defined early in the program's development, and is still applicable today:

> ***CHART strives to improve mobility and safety for the users of Maryland's highways through the application of ITS technology and interagency teamwork.***

CHART accomplishes its mission by focusing on mitigation of non-recurring congestion that occurs due to events such as crashes, breakdowns, construction, and weather. Non-recurring congestion is now the cause of about 50 percent of Maryland's highway congestion. Recurring congestion – generally caused by too much traffic on highways with too little capacity – accounts for the other fifty percent.

Looking Forward – The Potential of CHART

This document, the 2008 version of the CHART Non-constrained Deployment Plan (NCDP), is an update to the original plan released in 2005. The original intent of the 2005 NCDP was to build upon previous CHART planning efforts by looking far beyond them. The fundamental difference between the NCDP and other CHART planning efforts, notably the MDSHA Office of CHART Business Plan and CHART Deployment Plan, is that those plans are constrained by several factors that preclude MDOT and MDSHA from fully envisioning the CHART program's true potential. More specifically, the original NCDP:

- Depicted an ideal perspective as to how CHART should be operating several years down the road by looking past various constraints
- Expanded the breadth of the CHART program by addressing emergency operations, including adverse weather, security, and evacuation

- Extended the geographic breadth of CHART operational coverage, beyond central Maryland, to the entire state
- Defined more coordination with other state, regional, and local agencies, as well as other modes
- Advanced current CHART operations for mitigating non-recurring congestion
- Identified priorities, cost estimates, and approaches to provide a long-term course of action to reach the CHART program's potential

This 2008 update builds on the 2005 CHART NCDP by incorporating the following significant changes:

- Defining Emergency and Weather Operations as one of CHART's six fundamental program elements, as has been done in the latest CHART Business Plan
- Recording the CHART Program's progress in deploying Projects from the 2005 NCDP
- Updating the NCDP to take into account the latest systems and technologies CHART has planned and deployed since 2005
- Updating the NCDP to take into account institutional decisions and arrangements made within and external to the CHART Program
- Updating the NCDP to include the latest transportation operations and technology applications available to CHART, along with associated cost estimates
- Updating the priority of CHART NCDP Strategies

In short, the NCDP provides MDSHA a picture of a model CHART system without significant constraints. It can be viewed as a palette of ITS deployment projects for inclusion in future CHART Business Plans for years to come.

Benefits and Customer Service

Cost of Congestion

The 2007 version of the Annual Urban Mobility Report – a widely acknowledged study by the Texas Transportation Institute (TTI) – released 2005 statistics that indicate an average yearly cost of $520 per person due to congestion in 437 urban areas in the United States, costing $78 billion in extra time and fuel. Average yearly costs in the Baltimore and Washington, D.C. urban areas were estimated at $881 and $1,094 per person, respectively.

The TTI report states that, in considering estimated growth levels in the 437 urban areas studied, current spending for new road construction needs to be at least doubled in order to prevent a worsening in today's congestion levels. In general, new construction is viewed as an appropriate response to recurring congestion. TTI points out that, because raising highway construction budgets to these levels is unlikely, adding travel capacity through new construction can only serve as part of the total solution to solving congestion.

Non-recurring Congestion and Transportation Systems Operations and Management

New construction does not address non-recurring congestion, which is approximately half of the congestion problem. In the Baltimore and Washington, D.C. urban areas, TTI estimates that 55% and 50%, respectively, of total delay is due to non-recurring conditions. The other part of the perceived solution, which addresses non-recurring congestion, is known as Transportation System Management and Operations. Table 1 provides an overview of the two types of congestion, some of their causes, as well as the two different types of strategies to mitigate those causes.

Table 1 - Types of Congestion with Usual Mitigation Strategy

Type of Congestion	Representative Causes of Delay	Mitigation Strategy
Recurring	Infrastructure capacity shortfalls	Capacity increases
	Interchange bottlenecks	
	Weave and merge friction	
	Non-optimized traffic signal timing*	Transportation Systems Operations and Management
Non-recurring	Breakdowns and crashes	
	Construction work	
	Weather	
	Vehicle mix	

* Note that while non-optimized signal timing will lead to recurring congestion, it is addressed through better operations and management, not new capacity.

In the past, highways were built and then there was comparatively little emphasis on effectively operating and managing day-to-day traffic on the highway system. As resources for new construction have become scarcer, and as highways have become more congested, attention has been focused on strategies to more effectively move traffic on a day-to-day basis. Applying a range of such strategies will collectively decrease levels of congestion and delay, increasing the reliability of travel times. These strategies also provide greater safety to the traveling public.

CHART's Contribution

In Maryland, the CHART program is MDSHA's primary contributor towards enhanced system management and operations. In essence, the CHART program was established to tackle approximately half of the congestion problem that is non-recurring. Other MDSHA programs also contribute, e.g., traffic signal optimization program. Additional representative agencies that contribute include the Maryland State Police, especially for incident clearance, and transit agencies to the extent they are able to provide service that reduces highway congestion.

The CHART program – sometimes in conjunction with other programs and agencies – has made a beneficial difference, especially in the incident management arena. In the year 2007 alone, the CHART program's focus on non-recurring congestion returned $1.118 billion in savings from fewer delayed vehicle hours to Maryland travelers, reduced incident durations by 41% (average from 2000 to 2007), and significantly lowered emissions levels. These benefits continue to accrue year-after-year and, in fact, are growing over time.

Qualitatively, beyond existing benefits, additional benefits that will be experienced through extending CHART's programs based on Projects within this Plan include:

- More efficient, useful, and personalized traveler information
- Increased safety along freeways, at work zone locations, and at highway/rail crossings
- Increased mobility at inter-modal transfer points
- Increased adverse weather and emergency management, as well as evacuation services
- More secure and redundant transportation management services
- Safer and quicker management of roadway incidents at multi-jurisdictional locations
- Increased mobility on arterials/surface streets, tolled roadways, and event/work zone locations
- Increased real-time traffic management and traveler information services through use of the latest technological tools
- Increased safety, mobility, and reliability due to coordinated management of commercial vehicles and hazardous material shipped along roadways

Resource Imbalance Between Congestion Solutions

As noted above, Maryland's CHART program addresses roughly 50% of the delay and lack of system reliability not addressed by the Administration's capital improvements program, and does so in a highly effective manner.

The Consolidated Transportation Plan (CTP) allocation for CHART for fiscal years 2008-2013 shows expenditures of $12.8 million in capital costs and $8.44 million in operations and maintenance costs in 2008. At the current level, funding for the CHART program will be approximately $127 million over the next six years. In comparison, funding for MDSHA capital costs is budgeted at $5.6 billion for the same six-year period in the 2008-2013 MDOT CTP. Furthermore, Maryland's new highway infrastructure construction needs are estimated at $51.4 billion in the MDSHA Highway Needs Inventory – a high-level estimate based on serving existing and projected population and economic activity.

While CHART is not the only program involved in management and operations of the state highway system, it is a large part. Therefore, as may be seen, the proportionate share of funding devoted to Transportation Systems Operations and Management tends to be relatively small compared to new construction. Given the difficulty in keeping pace with congestion through new construction, focusing additional attention on the operations and management part of the congestion solution through increased funding could pay large dividends.

Planning Structure

The CHART Non-constrained Deployment Plan is composed of a series of Elements, Objectives, Strategies, and Projects. The NCDP Elements are consistent with the six program Elements defined by CHART within the MDSHA planning framework. Table 2 lists the six Elements, and provides total capital cost estimates for each.

Objectives within this Plan offer the CHART program a specific target for the accomplishment of sustaining the six program Elements. They provide a high-level description of the sort of operations that will need to take place, and the underlying purpose behind those operations. In this manner, the Objectives were used as the primary basis to build the various deployment Strategies. The 17 NCDP Objectives are displayed in Table 3, along with associated total capital cost estimates.

Using the Objectives as a foundation, the NCDP Strategies were developed. This Plan presents ITS deployment Strategies as a group of functional benefits and associated activities that CHART will undertake in order to achieve the

operational capability defined in the associated Objective. The NCDP Strategies are provided in Section 3.1, along with associated priority ratings.

The NCDP Projects give a physical description of what needs to be deployed to realize the functionality outlined by the Strategies. As such, each Project will primarily support the implementation of a specific deployment Strategy. A list of Project names is provided in Section 3.2, along with associated capital cost estimates.

Resource Estimates

Capital cost estimates for implementing the NCDP for CHART's six traditional program elements are reflected in Table 2. All cost estimates within the NCDP are in current dollars, and not adjusted for inflation.

Table 2 - Capital Cost Estimates by Traditional CHART Elements

CHART Element	Total Capital Cost Estimate
Traffic and Roadway Monitoring (TRM)	$97,716,500
Incident Management (IM)	$28,478,000
Traveler Information (TI)	$76,671,000
Traffic Management (TM)	$16,065,000
Systems Integration and Communication (SIC)	$44,434,500
Emergency and Weather Operations (EWO)	$36,584,000
NCDP Total Capital Cost Estimate	$299,949,000

Table 3 restates the above capital cost estimates for the 17 Objectives that are defined within the NCDP.

Table 3 – Capital Cost Estimates by CHART NCDP Objectives

Number	Objective	Capital Cost Estimate
1	Enhance CHART's ability to visually monitor highway conditions.	$55,693,500
2	Enhance CHART's ability to collect automated traffic data from traffic detection sites.	$29,920,000
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data, and reduced infrastructure requirements.	$5,925,000
4	Enhance CHART's ability to monitor travel conditions during inclement weather.	$16,125,000

Number	Objective	Capital Cost Estimate
5	Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	$18,655,000
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	$1,496,000
7	Enhance CHART's severe weather and emergency management operations.	$14,859,000
8	Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	$35,280,000
9	Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	$35,975,000
10	Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	$5,400,000
11	Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	$5,800,000
12	Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	$160,000
13	Enhance ability to manage traffic and increase safety near and within work zones and event locations.	$2,245,000
14	Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	$6,356,000
15	Increase motorist roadway safety and deploy systems to enhance safety at highway rail crossings.	*
16	Develop additional capabilities within the CHART Operating System Software.	$47,496,000
17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices	$18,563,500
NCDP Total Capital Cost Estimate		$299,949,000

* Objective 15 does not have a capital cost estimate because it only consists of Strategies in which CHART is acting in a supporting role to another agency initiative (see Section 2.4.3). In these supporting roles, CHART may incur little or no capital costs.

The total cost of the NCDP is reflected in Table 4 below.

Table 4 – CHART NCDP Total Cost Estimates

CHART NCDP Costs	Total Cost Estimate
Capital Cost	$299,949,000
Pre-deployment (Studies and Engineering) Costs	$29,994,900
20-year Operations and Maintenance Costs	$420,639,219
Total	$750,583,119.00

In short, implementation (approximately $300 million capital, and $30 million pre-deployment) and 20-year operation and upkeep (approximately $421 million) of the complete capital plan within the CHART NCDP is a small percentage of the estimated $51.4 billion in needed statewide highway construction improvements.. However, the CHART program represents MDSHA's primary contribution to managing and operating existing roads, addressing approximately half of what causes congestion, delay, and lack of reliability for Maryland travelers.

What's in the 2008 NCDP?

The NCDP Introduction (Section 1) sets the context with which the NCDP was developed and provides an overview of the CHART mission, MDSHA's organizational planning process, and previous CHART planning efforts.

The Plan Overview (Section 2) sets forth the:

- Purpose of the NCDP
- How NCDP fits into overall CHART Planning Process
- NCDP Scope
- Planning structure: Elements, Objectives, Strategies, and Projects
- NCDP cost estimates

The Strategies and Projects section (Section 3) details prioritized CHART program Strategies identified to continue implementing each Objective, as well as Projects and cost estimates to implement each Objective.

The Benefits of CHART section (Section 4) summarizes current quantitative benefits of the CHART program, as well as potential additional qualitative transportation and economic benefits, resulting from the implementation of the NCDP.

The Appendices provide additional information, including more detailed Project definitions.

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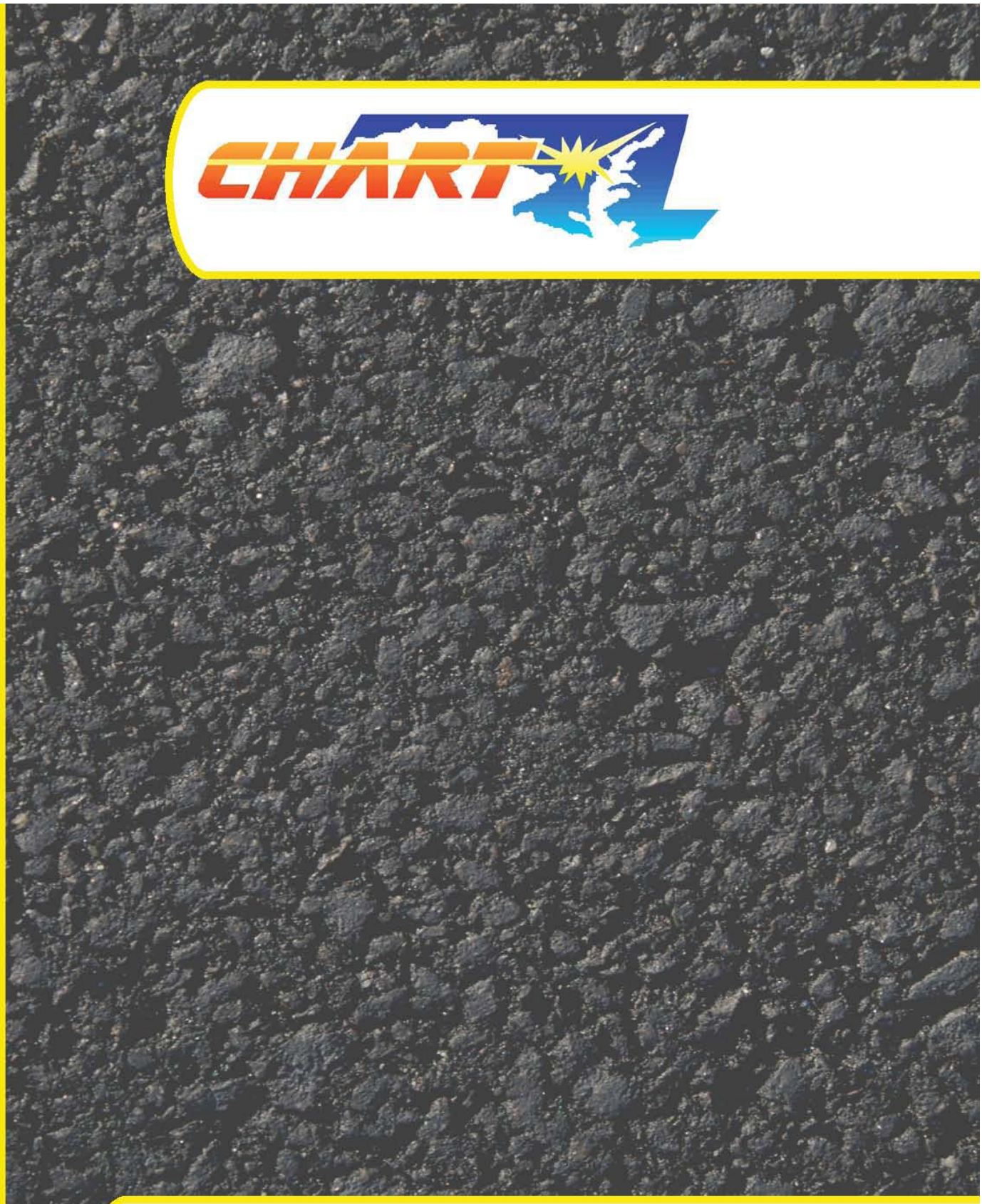

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SHA
State Highway
Administration
Maryland Department of Transportation

Martin O'Malley
Governor

Anthony G. Brown
Lt. Governor

John D. Porcari
Secretary of Transportation

Neil J. Pedersen
State Highway Administrator

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1. Introduction

Intelligent Transportation Systems (ITS) involve the application of technology solutions to transportation challenges as well as close interagency cooperation and coordination to implement these solutions. Specifically, ITS solutions are becoming an important tool for managing non-recurring factors (e.g., crashes, breakdowns, construction, and weather) that cause approximately half of all delay along roadways.

The Coordinated Highways Action Response Team (CHART) is the highway operations element of Maryland's ITS Program. CHART is a joint effort of the Maryland Department of Transportation (MDOT), Maryland State Highway Administration (MDSHA), Maryland Transportation Authority (MdTA), and Maryland State Police (MSP), in cooperation with other federal, state, and local agencies.

CHART's mission was defined early in the program's development, and is still applicable today:

> ***CHART strives to improve mobility and safety for the users of Maryland's highways through the application of ITS technology and interagency teamwork.***

The CHART program relies on communication, coordination, and cooperation among agencies and disciplines, both within Maryland and with neighboring states, to foster the teamwork necessary to achieve its mission. CHART's mission is consistent with MDSHA's overall mission, which is to efficiently provide mobility for our customers through a safe, well-maintained and attractive highway system that enhances Maryland's communities, economy and environment.

The genesis of CHART can be traced back to the mid-1980s, when a program known as "Reach-the-Beach" was initiated to help improve travel to and from Maryland's Eastern Shore and the urban areas of Baltimore and Washington. "Reach-the-Beach" developed into a multi-jurisdictional and multi-disciplinary initiative that extended into the Baltimore-Washington Corridor and provided the foundation for a statewide ITS program.

The supportive technologies underlying CHART are rapidly changing, requiring a management style that responds to and anticipates these changes. In addition, the management of CHART needs to respond to, anticipate, and capitalize on opportunities for cooperation with a wider and more diverse group of public agencies and private organizations, so as to better fulfill its mission.

A requirement within the MDOT organizational planning process is for each responsibility center to contribute its portion within the MDOT capital plan, which CHART does on a yearly basis However, unlike the majority of other MDSHA programs, CHART is based on concepts, strategies, and technologies that have only become available within the past fifteen years. This has led to a planning process that is comparatively more iterative and potentially more dynamic than other MDSHA offices, and which must be updated as customers' requirements of the CHART program evolve along with the transportation improvement technologies it deploys.

Because CHART needs to be in continuous pursuit of the latest advancements in ITS, it is essential there be corresponding planning efforts to identify the ever-changing user needs, as well as the strategies that are available to meet those needs. There have been several planning efforts that consider the extension of the CHART program past its conventional incident management and highway operations in order to take on more diverse transportation challenges by employing various innovative ITS solutions.

There are, however, numerous transportation operations and technology applications that can significantly enhance the CHART program but are beyond what is considered feasible when taking into account today's institutional and resource constraints. It is important to consider the potential of these deployments in order to depict an ideal or model target for the CHART program. In this manner, the CHART program will be more compatible with tomorrow's transportation system user needs, as well as be more prepared for deploying the latest ITS solutions should today's constraining factors become less significant.

2. Plan Overview

In order to exhibit how the program is considering the latest available transportation solutions, CHART has initiated the development of this plan. The document's general aim is to paint a picture of what transportation-related solutions are available in order to continue effectively serving Maryland travelers.

2.1 Purpose

The broad purpose of the Non-constrained Deployment Plan (NCDP) is to identify priorities, costs, and approaches for the MDSHA to continue the process of deploying ITS technology throughout the state.

This 2008 version of the CHART Non-constrained Deployment Plan is an update to the original NCDP released in 2005. The original intent of the 2005 NCDP was to build upon previous CHART planning efforts by looking far beyond them. The fundamental difference between the NCDP and other CHART planning efforts, notably the yearly MDSHA Office of CHART Business Plan and CHART Deployment Plan, is that those plans are constrained by several factors that preclude MDOT and MDSHA from fully envisioning the CHART program's true potential. More specifically, the original NCDP:

- Depicted an ideal perspective as to how CHART should be operating several years down the road by looking past various constraints
- Expanded the breadth of the CHART program by addressing emergency operations, including adverse weather, security, and evacuation
- Extended the geographic breadth of CHART operational coverage beyond central Maryland to the entire state
- Defined more coordination with other state, regional, and local agencies, as well as other modes
- Advanced current CHART operations for mitigating non-recurring congestion
- Identified priorities, cost estimates, and approaches to provide a long-term course of action to reach the CHART program's potential

This 2008 update builds on the 2005 CHART NCDP by incorporating the following significant changes:

- Defining Emergency and Weather Operations as one of CHART's six fundamental program elements, as has been done in the latest CHART Business Plan

- Recording the CHART Program's progress in deploying Projects from the 2005 NCDP
- Updating the NCDP to take into account the latest systems and technologies CHART has planned and deployed since 2005
- Updating the NCDP to take into account institutional decisions and operational agreements made within, and external to, the CHART Program
- Updating the NCDP to include the latest transportation operations and technology applications available to CHART, along with associated cost estimates
- Updating the priority of CHART NCDP Strategies

2.2 NCDP within the CHART Planning Process

After several years of experience in deploying Intelligent Transportation Systems (ITS), the Maryland State Highway Administration has established a process within its CHART Program for planning, programming, designing, building, operating, and maintaining ITS to provide benefits to its customers. This section provides a high-level description of the planning and programming portion of the CHART Program deployment process, and demonstrates how the NCDP fits within that process.

As shown in Figure 1 below, planning is the initial step within the CHART ITS project deployment process. Once an operational need is established for a particular CHART project, it is first planned using inputs from all relative users and stakeholders, and then the appropriate funding is programmed to carry out the project. Once planning and programming efforts have been conducted, the project then (typically) enters into the design phase. Following the final design acceptance, the project is then constructed or deployed, and acceptance testing is conducted on the final deployment. Eventually, the deployed assets are integrated into the CHART operational system, and then operated and maintained for a number of years until the life expectancy is met. As can be seen in Figure 1 below, the overall CHART deployment process is cyclical. When life expectancies of deployed assets are met there becomes a need for replacement assets to be deployed through a new project. The CHART Board of Directors oversees the entire life-cycle of each ITS Project.

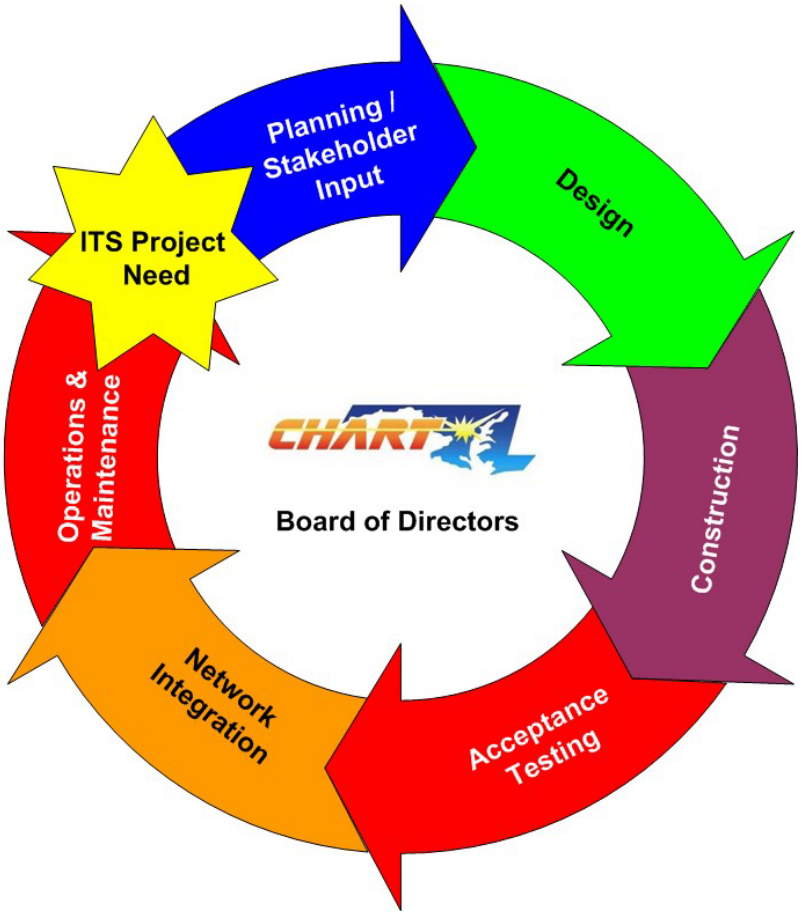


Figure 1 – CHART ITS Project Deployment Process

This section includes the identification and descriptions of the high-level steps within CHART's project planning and programming process. As such, it is intended to provide a high-level look into CHART's planning and programming process, and how the CHART Deployment Plan fits into that process. It should be noted that it is not intended to be a guide describing each step required for CHART staff to plan a deployment, rather, it is intended for an outside audience to understand both preceding and subsequent planning actions within the process as a whole. Figure 2 below provides the CHART Program's project planning and programming process.

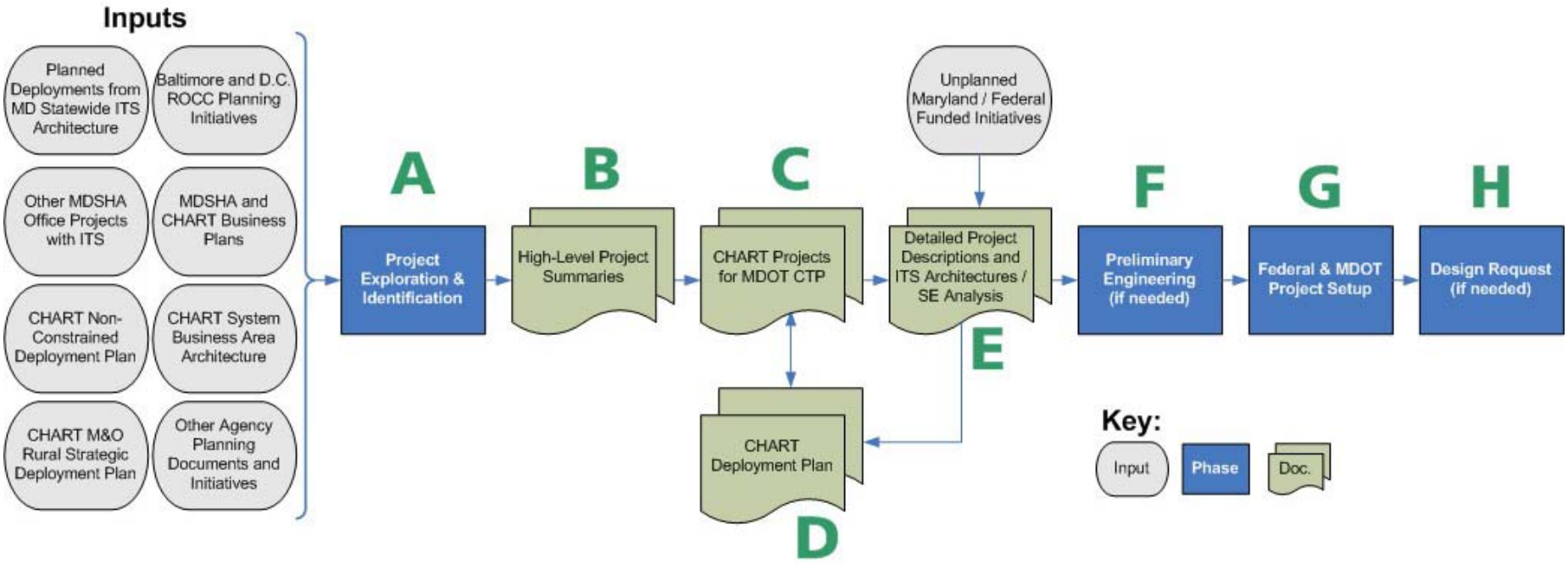


Figure 2 – CHART Project Planning & Programming Process

Note that in Figure 2 those items denoted by blue boxes represent phases/tasks within the CHART planning process; items denoted by the gray ovals represent inputs into the planning process; and items denoted by the dark green pages represent documents within the planning process. It should also be noted that the lettered notes on the phases/tasks and documents cross-reference the descriptions in the following paragraphs, and are not necessarily in chronological order.

A – Project Exploration and Identification

This phase in the CHART project planning and programming process involves gathering information from various inputs that are both internal and external to the CHART Program. One of the CHART Program primary objectives is to coordinate with other offices/agencies/partners in order to effectively operate Maryland roadways. As such, CHART has an established place within several forums and processes that involve planning interaction with other agencies (e.g., bordering/regional states, local and county agencies, other state modal transportation agencies, public safety agencies, emergency and medical operational agencies, among others), as well as other offices within MDSHA. Similar to CHART, these partner agencies also have planning processes and documented initiatives, many of which identify resources that CHART will be responsible for deploying/providing. CHART planning efforts therefore also need to account for various CHART resources allocated to support other agency initiatives.

In addition to inputs from outside agencies, there are various inputs from within the CHART Program that identify operational needs and resources to be deployed through future projects. These include (but are not limited to):

- Planning and/or design documentation developed for specific systems or efforts within the CHART Program (e.g., the CHART Business Area Architecture is a planning/requirements document for the CHART II operating platform);
- Input (documented or not) on operational needs from CHART operational staff in CHART centers or in the field; and
- Operations and maintenance data related to the need to replace existing infrastructure that is beyond or reaching its life expectancy.

It should be noted that the Project Exploration and Identification Phase is not necessarily sequential within the overall CHART project planning and programming process depicted in Figure 2. That is, planning inputs can be taken into account at any point within the process. For instance, some planning inputs

are impromptu and bypass preliminary planning stages to be entered directly into the project setup phase to receive funding and programming.

The following provides a description of several different inputs within the CHART project planning and programming process

Baltimore and DC ROCC Planning Initiatives – some CHART Projects have originated from either the Baltimore or Washington, DC Regional Operation Coordination Committees (ROCC). These committees combine representatives from agencies that have a stake in transportation operations within the respective region. The general purpose of the ROCC is to identify multi-agency transportation coordination issues throughout the region, define projects and needed resources to address those issues, and to generally foster regional cooperation in transportation management. CHART has historically provided staff coordination and resources for various projects that originated in the ROCC – primarily related to regional incident management initiatives.

Planned Deployments from MD Statewide ITS Architecture – The Maryland Statewide ITS Architecture fulfills a USDOT requirement for MDSHA Office of CHART and other participating stakeholders to receive federal funding for ITS projects. The Maryland Statewide ITS Architecture initiative has had two iterations: 1999 and most recently in 2005. The broad purpose of the ITS Architecture is to document existing and planned interconnects between systems operated by transportation agencies throughout Maryland. Additionally, the ITS Architecture identifies information that is exchanged between transportation systems throughout Maryland, and does so based on the National ITS Architecture framework and associated system standards.

The Maryland Statewide ITS Architecture was developed from coordinated input by stakeholder agencies. The documentation and associated system diagrams define functionality and information exchanges that are existing or planned for future deployment. As such, the CHART Program bases capital improvement projects on planned system functionality and information exchange defined in the Maryland Statewide ITS Architecture.

Other MDSHA Office Projects with ITS – Currently, ITS deployments are found in various types of MDSHA projects that are managed by other MDSHA offices. In these cases, the Office of CHART will often provide preliminary planning and design services to identify operational characteristics of a deployment (e.g., location and viewing angles of a camera), as well as the needed system hardware, power, and communication services to integrate the deployment into the CHART system. It should be noted that these cases do not typically involve

Office of CHART responsibilities for capital expenditures or overall project management services; rather, these projects involve CHART resources for planning and integration support.

MDSHA and CHART Business Plans – The Maryland State Highway Administration's Business Plan is an established process for tracking progress toward accomplishing its mission, vision, and values. The MDSHA Office of CHART is responsible for contributing to the MDSHA Business Plan through its own Business Plan, which identifies the specific CHART mission, vision, and values within the overall MDSHA Business Plan framework. The Business Plan framework is primarily driven by Key Performance Areas (KPAs), Objectives to meet the KPAs, and performances measures to define progress. While much of the CHART Business Plan involves performance measures for non-capital improvements (e.g., employee satisfaction), the plan does define future deployments and objectives that contribute to the identification of CHART projects.

CHART Non-Constrained Deployment Plan – The CHART Non-Constrained Deployment Plan (NCDP) is a planning document that is updated every two years. Its primary purpose is to depict an ideal perspective of how CHART should be operating several years in the future without applying functional, budgetary, political, or time constraints. The NCDP does this by providing an organized framework for tracking the latest technologies and operational applications available to the CHART Program. The primary source of project planning input is within the project definitions, which are included as an appendix to the NCDP. Each project definition includes the project description, benefit, scale, associated technology, cost estimate, related Strategies (as defined within the NCDP), cost assumptions, and status. The NCDP has proven to be an especially valuable tool for identifying technology applications that are available for distant future deployments; this is specifically beneficial in identifying projects within the MDOT Consolidated Transportation Program (CTP – see below) that fall in the fifth and sixth programmed years.

CHART System Business Area Architecture – the CHART Business Area Architecture (BAA) is a document that defines the current and future CHART system operational vision. This includes: designed business processes for relationships to organizations, technology, and facilities; defined, distributed, and integrated applications and data entities across platforms and locations; a developed system architecture at the conceptual level for technical infrastructure; and defined, interrelated, and scheduled releases within the business change program. The document is specific to the CHART system and the operation of the system, including software, hardware, and communications infrastructure. It

includes a significant amount of needs/requirements related to operational capabilities to be built into the CHART system. These needs and requirements are used as input for identifying CHART projects.

CHART M&O Rural Strategic Deployment Plan – This document was developed to define the Management and Operations/ITS Planning and Development needs of Rural Maryland that would lead to reduced seasonal highway congestion, better information to motorists concerning evacuation and emergency procedures, and, improved communication with other parts of the State and neighboring regions. Using input/information obtained from a series of stakeholder meetings, the M&O/Strategic Deployment Plan focuses on various strategies to support weather, evacuation, seasonal/everyday traffic, special events, and safety issues within the rural parts of Maryland. The plan also provides a schedule for each deployment as well as documentation associated with the estimated costs.

Other Planning Documents and Initiatives – There are several other examples of planning documents and initiatives that provide input into the CHART Project Planning and Programming process. These include, but are not limited to, the following:

- Direct / undocumented input from CHART personnel on operational needs to be met by deployment projects
- Planning documents or deployment initiatives by other agencies that include CHART support and/or capital deployments
- Internal MDSHA / CHART Strategic Plans – often particular to an operational area (e.g., CHART M&O Rural Strategic Deployment Plan), these plans define future operational conditions and/or capital deployments
- CHART Multi-Modal Functional Vision – a 2001 planning document that focused on extending the breadth of CHART program coverage throughout the State, as well as CHART deployments for coordinated operations with other modal agencies.

Unplanned State / Federal-Funded Initiatives – These project exploration and identification inputs occur when special needs or opportunities arise where formal planning processes have not been fully carried out but a project is initiated regardless. This typically happens when unexpected funding sources become available, or if an operational priority surfaces. As can be seen in Figure 2 – in these cases the project bypasses formal documentation in the MDOT CTP and CHART Deployment Plan, and is documented directly within a detailed project description and/or a project-level ITS architecture / SE analysis. From there, the

project continues through the process to be officially programmed in the Federal and/or MDOT project systems.

B – High-Level Project Summary

Once projects are identified in the initial phase of the CHART Planning and Programming Process, official documentation of the project is initiated through the high-level summary process prior to being entered into the MDOT Consolidated Transportation Program (CTP) to begin the programming process. In short, the high-level project summary serves as a placeholder within the CHART planning process. These summaries do not require a great deal of resources to produce, and therefore are typically done prior to final decisions on whether/and how the project will be carried out. More detailed project descriptions and preliminary design efforts are completed closer to the point where the project is going to be fully designed, budgeted for, and programmed into the Federal and/or MDSHA project tracking systems as a formal project.

High-level project summary documentation typically includes:

- Project Title
- Preliminary cost estimate
- Rough scope definition (i.e., a paragraph describing equipment to be deployed, and estimated number of devices)
- Projected implementation schedule (i.e., estimate of when project will be implemented, and duration of project)
- High-level benefits and needs addressed (i.e., paragraph explanation)

C – CHART Projects for MDOT CTP

The Maryland Consolidated Transportation Program (CTP) is released yearly by the Maryland Department of Transportation (MDOT). It includes ongoing and future capital investments for all modes of transportation within Maryland for the next six-year timeframe. The Maryland State Highway Administration and the Office of CHART, being part of MDOT, is responsible for contributing its portion of the six-year capital investment program within the CTP.

As such, the Office of CHART contribution to the MDOT CTP includes project titles and cost estimates to be programmed over the next six years. This includes budget projections for each project in yearly increments. CHART updates its projects and budgets every year for submittal to the MDOT CTP, showing the latest CHART capital investment six-year projection.

Within the CHART project planning and programming process, the CTP documentation phase is carried using project titles and cost estimates that were developed within the High-Level Project Summaries Phase. Typically, only when a project has been documented within the CTP will a detailed description be developed for the project in the next phase. However, there are exceptions where some projects move forward without being formally documented in the most recently released MDOT CTP.

The CHART Projects for MDOT CTP documentation also directly coincides with the CHART Deployment Plan, as can be seen in Figure 2. This is because the CHART Deployment Plan is a detailed representation of projects that have been documented (or will be documented) in the most recent CTP.

D – CHART Deployment Plan

The CHART Deployment Plan presents and describes capital improvement projects that the MDSHA Office of CHART is responsible for within the six-year MDOT CTP (as described above). The CHART Deployment Plan is updated on an annual basis. The primary purpose behind the CHART Deployment Plan is to document detailed information on CHART projects to receive funding for the next six years through the CTP. As such, the CHART Deployment Plan directly coincides with the CHART Projects for MDOT CTP document within the CHART Project Planning and Programming Process, as can be seen in Figure 2.

The CHART Deployment Plan is a compilation of projects that either have a high-level or detailed project description. High-level project summaries are included for those projects that do not yet have a detailed project description developed, or those projects that are planned for more distant year deployments. Those projects that have started deployment, close to project initiation, or are close to being programmed as an official project will have had detailed project descriptions in the CHART Deployment Plan. As can be seen in Figure 2, once a detailed project description is developed or updated for a project, it is used as input back into the next iteration of the CHART Deployment Plan.

E – Detailed Project Descriptions and ITS Architectures / Systems Engineering (SE) Analysis

This level of documentation takes place once projects are documented in the MDOT CTP and the CHART Deployment Plan. The Detailed Project Description and ITS Architecture / SE Analysis Phase is required to be carried out prior to a project going through the Preliminary Engineering Phase (if applicable), and eventually entered into the Federal and MDOT Project Setup Phase.

The detailed project descriptions document information that is required by MDOT and MDSHA to begin the project setup process. In general, the detailed project descriptions expand on the information within the high-level project summaries to include details that are required to secure state funding. Detailed project description documentation typically includes:

- Project title
- Brief project description and/or background
- Project cost estimate
- Detailed scope (e.g., system functionality, location, number of devices, etc.)
- Project tasks and/or milestones
- Project schedule
- High-level benefits and needs addressed (i.e., paragraph)
- Project funding source

The project-level ITS architecture and SE compliance documentation is carried out to fulfill the Federal Highway Administration (FHWA) rule on Intelligent Transportation Systems (ITS) Architecture and Standards, which implements section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21). This final rule/policy requires that ITS projects funded by the Highway Trust Fund conform to the National ITS Architecture. Part of this process includes a project-level architecture, as well as a systems engineering analysis.

The systems engineering analysis is a structured process that is used to help reduce the risk of schedule and cost overruns by accounting for variables affecting the system being deployed. The Project ITS Architecture is based on the results of the SE analysis, and defines specific system data exchanges and functions being deployed by the project. It is developed using applicable system exchanges documented in the Maryland Statewide Architecture, and once completed, the Project ITS Architecture identifies, in turn, any project-related updates that need to be made to the Statewide Architecture. The following is a more detailed list of what the Project ITS Architecture and systems engineering analysis includes.

Systems engineering analysis documentation is required to include:

- Identification of portions of the Maryland Statewide ITS architecture being implemented
- Identification of participating agencies roles and responsibilities;
- Requirements definitions;

- Analysis of alternative system configurations and technology options to meet requirements;
- Procurement options;
- Identification of applicable ITS standards and testing procedures; and
- Procedures and resources necessary for operations and management of the system.

The project level ITS architecture is based on the results of the systems engineering analysis, and is required to include the following:

- A description of the scope of the ITS project;
- An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the ITS project;
- Functional requirements of the ITS project;
- Interface requirements and information exchanges between the ITS project and other planned and existing systems and subsystems; and
- Identification of applicable ITS standards.

F – Preliminary Engineering (If Needed)

This phase is preceded by Detailed Project Description, ITS Architecture/SE Analysis documentation, and is completed prior to the Federal/MDOT Project Setup Phase. Once the needed project information is documented in the detailed project descriptions and/or systems engineering analysis/project-level ITS architecture, the project can enter the preliminary design phase where all needed details about the deployment are gathered prior to beginning the final project design.

It should be noted that not all Office of CHART projects require preliminary engineering services. An example could be where specific equipment will simply be procured through the project, and therefore engineering design services are not needed. In general, the most common type of projects that require preliminary engineering services are those where ITS field devices are being deployed in new locations. A preliminary engineering report will be completed to document outcomes from the preliminary engineering phase. These reports typically include the following for each field device location/site:

- Roadway and site characteristics/conditions – county, route, direction of travel, nearest milepost, geographical coordinates, offset of road, etc.
- Landscape features/usage
- Special features

- Personnel conducting survey
- Obstructions
- Power/communications notes on availability or issues
- Comments/suggestions
- Additional reference material, typically including: a map of the location, images of viewing angles (especially for cameras), reference images from site survey

G – Federal & MDOT Project Setup

This phase is preceded by Preliminary Engineering phase, and is completed prior to the "Design Request" (if needed), which is the final phase within the overall process. When preliminary engineering services are carried out and documented, the project needs to be set up in the Federal and/or MDOT project tracking systems, which track budget, payments, scheduling, etc. As discussed above, those projects that do not require a project-level ITS architecture and/or a systems engineering analysis, and/or preliminary engineering services may be entered directly into the project setup phase. Typically, much of the documentation conducted in the previous phases is used to fill out the appropriate forms to set the project up in the respective system(s).

The following represents documentation typically required and used for USDOT/FHWA project setup:

- Project-level ITS architecture
- Systems engineering analysis

These items are typically used for MDOT project setup:

- Detailed project descriptions
- Preliminary engineering services

H – Design Request (If Needed)

This phase is preceded by the Federal and MDOT Project Setup and is the last phase within the process. Once the project is setup in the USDOT/FHWA and/or MDOT project system, it can then move forward with design and deployment services. As such, the Office of CHART typically does not conduct design services for many of the projects it initiates through its planning process, and therefore, a design request is submitted by CHART to the Office of Traffic and Safety (OOTS) in order to officially move project design and construction management services to OOTS. This phase also moves the planning and programming process into project design and deployment.

It should be noted that not all Office of CHART projects require design service requests. Under circumstances where system hardware or software is being procured, site engineering design may not be required. Cases where design services will be conducted internally by CHART rather than by OOTS would also have no need for design requests.

When completed, the Design Request submitted by CHART to OOTS includes:

- High-level project summary / title
- Project location and limit
- Funding source
- Estimated costs
- Specific device location information (typically accompanied by a map)
- Additional reference material (e.g., preliminary engineering report)
- OOTS design request forms

2.3 Scope

As previously stated, part of the overall rationale for developing the initial NCDP in 2005 was to look beyond the ITS deployments provided by other CHART planning initiatives – doing so without applying any functional, budgetary, political, or time constraints – in order to provide a depiction of the future operational potential of CHART. This depiction will consequently provide the developers of future CHART planning documents an array of ITS deployments and initiatives from which to choose. The NCDP also has a role in assisting MDOT, MDSHA, and CHART to portray the potential benefit of ITS operations to various decision-makers. In this manner, the NCDP establishes CHART's commitment to expanding its functionality by using the latest available solutions in order to meet the needs of Maryland travelers.

The following is a discussion of the scope for the NCDP. The discussion focuses on the unique features of the NCDP when compared to other CHART planning initiatives.

Deployment Priorities

Priority is included in the NCDP for each deployment Strategy. Attaching priority to a non-constrained list of pursuits is important because it provides a distinction between those deployments that are more likely to offer an immediate benefit and those that will be more feasible in the future due to current constraining factors.

Defining priority can also create a sense of urgency for decision-makers to direct more attention to those deployments that will be most influential in meeting program goals. In this manner, the NCDP provides decision-makers, who have expressed a need for more clarity on priority than what was provided in previous CHART planning documents, a clear delineation of ITS deployment priority levels.

Deployment Constraints

Because the NCDP defines deployments without considering constraining factors, it allows the CHART program to consider how it will accommodate future user needs, as well as the ITS applications to answer those needs, by not putting constraints on what is feasible for CHART to implement today. This is significant because ITS planners can find it difficult to consider and plan for the latest technology applications and also determine what, specifically, will be feasible in the future.

In the NCDP, constraining factors excluded from the identification of potential CHART deployments were:

- Costs and budgetary constraints,
- Time constraints,
- Capacity of CHART network components and/or software constraints, and
- Political or institutional coordination constraints.

Constraining factors taken into account when defining deployments during development of the NCDP were that the deployment only be considered if it:

- Provides a specific benefit to CHART's customers,
- Is judged to be "reasonable", and
- Is consistent with CHART's mission.

Technologies

Due to the nature of this plan, all ITS technologies that facilitate transportation solutions were considered. These technologies include those that are not feasible due to the existing capability of the CHART system or the current operating priorities within the program. Therefore, the Plan provides a depiction of the full operating potential of CHART because it details existing ITS technologies that are not currently feasible due to institutional and resource constraints. The Plan also provides an outlook on technological advancement possibilities in the future.

The following Table 5 provides an overview of the basic scope of the CHART Non-constrained Deployment Plan.

Table 5 – CHART NCDP Scope

Scope Category	2008 Non-constrained Deployment Plan
What is the general purpose of the plan?	• Present CHART's vision of future operational potential • Consider latest transportation solutions in order to best expand CHART's functionality
Who is the audience?	• Governor • State Legislature • CHART • MDSHA • MDOT • Local Transportation Agencies • Multi-modal Agencies • General ITS Arena • Public
What is the plan's time span?	• 2008-Indefinite
What planning constraints were considered?	• Existing or significantly developed technology • Institutionally reasonable now or in the future

Table 6 presents how the NCDP defines ITS deployments.

Table 6 – CHART NCDP ITS Deployment Definition

ITS Deployment Definition Category	2008 Non-constrained Deployment Plan
Costs included for each deployment project?	Yes
Defined timeframe for deployment project?	No
Defined priority for deployment project?	Yes
What is general range of defined deployments?	Office of CHART (only) resources for: • CHART ITS initiatives • Broader CHART ITS initiatives, i.e., support of other agencies' initiatives
What range of technologies is defined?	• Existing proven technologies, from those that are fully developed to those not fully proven or fully developed

	• Technologies that extend conventional CHART operations to develop a broad operational perspective of future

2.4 Planning Structure

As stated in the Introduction Section of this document, the initial NCDP (2005) used the 2000 CHART Business Plan as a benchmark upon which to build. The 2000 CHART Business Plan followed a process called Managing for Results (MFR) that was implemented by Maryland in 1999 to provide state government offices a method of planning that would facilitate decision making, improve program performance, simplify resource allocation, increase customer satisfaction, and create public accountability. The MFR process is a multi-tiered system based on development of a Mission, Vision, Goals, Objectives, Strategies, and Action Plans. The Goals, Objectives, and Strategies all have measurable outcomes that allow for evaluation. The 2008 update of the NCDP continues this structure throughout this report. The Elements, Objectives, Strategies, and Projects included in this plan are described in the following sections.

2.4.1 Elements

Since its inception, CHART has used five program Elements (also called Goals): Traffic and Roadway Monitoring, Incident Management, Traveler Information, Traffic Management, and Systems Integration and Communications. Beginning in the 2007 CHART Business Plan, a sixth Element/Goal is included – Emergency and Weather Operations. Elements/Goals are defined within MFR as the general ends toward which an organization directs its efforts. They clarify the mission and vision and provide direction to meet customer needs.

2.4.1.1 Traffic and Roadway Monitoring

The intent of establishing the Traffic and Roadway Monitoring Element is to:

> *Improve highway safety and efficiency by augmenting CHART's ability to rapidly respond to hazardous highway conditions through enhanced traffic and roadway monitoring, including the use of new technology and additional device deployment.*

The NCDP defines Objectives, Strategies, and Projects within the Traffic and Roadway Monitoring Element that stipulate the continued deployment of monitoring capabilities necessary to enhance incident and traffic management

activities, as well as provide the data needed to disseminate information on current traveling conditions. Deployments for significantly extending traffic and roadway monitoring coverage are incorporated in order to ultimately encompass the entire CHART "primary coverage area" (Baltimore, Washington, Frederick, and Annapolis regions), and to do so by utilizing the latest advancements in technology applications. The Plan attempts to reflect the added emphasis of the CHART operations centers in collecting data from increasing numbers of devices in the field. Combination of public and private coordination (e.g., parking monitoring) is outlined as a possibility for the future of transportation system monitoring, as well as enhanced CHART support and deployment for the integration of monitoring operations across modal lines.

2.4.1.2 Incident Management

The intent of establishing the Incident Management Element is to:

> *Quickly and efficiently restore normal traffic flow after an incident by enhancing CHART's incident management program through training of personnel, technology solutions, and teamwork both internally and with other agencies.*

The NCDP extends the breadth of CHART Incident Management deployments by continuing to consider this functional area as a critical element for the CHART program. This is because managing events that cause non-recurring congestion quickly and safely will remain CHART's cornerstone for providing benefits to the public. Therefore, emphasis on traffic patrol coverage extension and incident response coordination efforts has been incorporated, as well as increasing technology applications that will enhance incident management coordination throughout the state.

2.4.1.3 Traveler Information

The intent of establishing the Traveler Information Element is to:

> *Provide timely and reliable mobility information to the traveling public both prior to travel and en-route through the use of roadside devices, electronic media, and public-private partnerships with information providers.*

Traveler Information deployments within the NCDP extend the scope of the current CHART Deployment Plan due to this functional area's potential for becoming the largest perceived benefit by the public. The NCDP defines how CHART will contribute to traveler information efforts to integrate various agency systems throughout, and beyond, the state. The vision involves collecting an

assortment of data types so that congestion, incident, weather, transit, and other forms of traveler information can be easily accessed by the public through a variety of dissemination mediums, eventually transitioning toward a “one stop shop” for statewide traveler information.

2.4.1.4 Traffic Management

The intent of establishing the Traffic Management Element is to:

> *Reduce congestion on highways by employing traffic management strategies to control vehicular movements, increase highway efficiency, and encourage travelers to choose alternative modes of travel.*

The NCDP expands on the current CHART Deployment Plan to support the Traffic Management Element by defining the implementation of more advanced technologies. These applications will vastly enhance CHART operational control of state freeways and expressways, and do so in harmony with the data collected by field monitoring devices. This Plan also presents deployments, initiatives, and support efforts that will increase CHART’s operational involvement with arterial traffic management, specifically in initiating automatic adjustments on surface arterials related to real-time traffic conditions on state freeways/expressways.

2.4.1.5 System Integration and Communications

The intent of establishing the System Integration and Communications Element is to:

> *Expand the CHART operating system and network to support inter-agency and inter-modal coordination, connectivity and sharing of transportation management information.*

Systems Integration and Communications will continue to be the backbone for providing the entire range of CHART services. The NCDP builds upon the foundation set by the current CHART Deployment Plan by calling for added deployments in software development and systems integration to allow the CHART operating system to communicate with added field devices, as well as new types of technologies that will be introduced in the communications/systems/software arena. The required capacity of the CHART network will need to continue growing as the demand for CHART’s operational functionality increases.

2.4.1.6 Emergency and Weather Operations

The intent of establishing the Emergency and Weather Operations Element is to:

Establish a secure and safe transportation system by deploying emergency response equipment and establishing coordinated preparedness and response plans for large-scale natural and man-made disasters, including adverse weather operations, terrorist activities and evacuations..

The 2008 CHART NCDP update is the first inclusion of Emergency and Weather Operations as a separate fundamental CHART Element. Where in the 2005 NCDP emergency and weather-related deployments were found throughout the other five Elements, MDSHA and CHART have since recognized the benefit in specifying deployments that support this increasingly important responsibility for the CHART Program. The 2008 NCDP defines emergency and weather operations to include resources and technology deployments for homeland security, evacuations, adverse weather, and large-scale event coordination. While many of the CHART resources used for incident management will also be used during emergency situations, the NCDP delineates deployments within the Emergency and Weather Operations Element as those which are typically not used on a day-to-day basis (as is the case for incident management operations).

2.4.2 Objectives

Objectives are defined as specific targets for the accomplishment of a goal. The Objectives were developed within the 2005 NCDP as a high-level description of the sort of operations that will need to take place, and the underlying purpose behind those operations. In this manner, the Objectives were used as the primary basis to build the various deployment Strategies. Note that edits or additions were not made to the 2005 NCDP Objectives for the 2008 NCDP update effort.

Table 7 presents the Objectives, and associated color-coding, defined within the 2008 NCDP.

Table 7 – Origin of CHART Objectives

Number	Objective
1	Enhance CHART's ability to visually monitor highway conditions.
2	Enhance CHART's ability to collect automated traffic data from traffic detection sites.
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data and reduced infrastructure requirements.
4	Enhance CHART's ability to monitor travel conditions during inclement weather.

5	Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.
7	Enhance CHART's severe weather and emergency management operations.
8	Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.
9	Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.
10	Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.
11	Utilize current technology and strategies to optimize flow of traffic on access controlled highways.
12	Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.
13	Enhance ability to manage traffic and increase safety near and within work zones and event locations.
14	Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.
15	Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.
16	Develop additional capabilities within the CHART Operating System Software.
17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices

2.4.3 Strategies

A Strategy is defined as a specific course of action that will be undertaken in order for an organization to achieve its goals and objectives. The NCDP presents ITS deployment Strategies as a group of functional benefits and associated activities that CHART will undertake in order to achieve the operational capability defined in the associated Objective. A total of 125 Strategies are included in this plan.

There are a few Strategies that are duplicated under more than one Objective. These Strategies are duplicated because the technologies that they will apply are intended to be versatile, and, therefore, are intended to be applied to several different types of operations. Within this plan, duplicated Strategies are primarily related to portable trailers with mounted ITS devices such as variable message signs (VMS) and closed-circuit television (CCTV) cameras. Such deployments can be utilized for Objectives related to traffic and roadway monitoring, work zone/event management, incident management, or emergency evacuation.

Support Strategies

Deployments are to be defined in the NCDP if they are the responsibility of the MDSHA Office of CHART. However, as CHART moves toward increased coverage and coordinated operations with other agencies and MDSHA offices, it becomes essential for CHART to support projects that are initiated and administered outside of CHART. The NCDP, therefore, includes and defines these efforts because they are carried out using some CHART resources. These deployments are designated as Support Strategies.

In order to more clearly define the level of support that CHART will be providing for other outside ITS initiatives, this Plan uses three categories for Support Strategies:

- Operations support – CHART allocates staff-hours to support other agencies in various tasks including patrols, traffic control operations, and emergency operations.
- Systems support – CHART funds the development of CHART system software and hardware interfaces in order to integrate data/systems/operations that are initiated and/or deployed by another agency.
- Planning/technical support – CHART allocates staff-hours to better coordinate CHART's role within the planning, analysis, and technical development stages of other agency initiatives/deployments.

2.4.4 Projects

The Strategies within the NCDP are intended to provide an understanding of the functional benefits of CHART deployments, whereas Projects provide a more practicable understanding of what CHART needs to build, develop, integrate, and initiate in order to achieve the functionality of the Strategies. Projects give a physical description of what needs to be built/developed to obtain the functionality outlined by the Strategies. As such, each Project will primarily support the implementation of a specific deployment Strategy. The 155 defined Projects and associated Objectives and Elements are described in Section 3.2 – Projects Grouped by Objective.

The NCDP defines Projects that are duplicated under more than one Objective, and follow the associated duplicate Strategies (see Section 2.4.3 above for details). These Projects are duplicated because the technologies they will apply are intended to be versatile, and therefore are intended to be applied to different types of operations. Within this plan, duplicated Projects are primarily related to portable trailers with mounted ITS devices such as variable message signs (VMS) and closed-circuit television (CCTV) cameras. Such deployments can be utilized for Objectives related to traffic and roadway monitoring, work zone/event management, incident management, or emergency evacuation. Note that the cost estimates associated with the duplicate Projects are only totaled once so as to not double-count them.

It is important to note that this Plan does not define Projects for Support Strategies, which identify deployments where CHART is responsible for allotting resources for other agencies' ITS initiatives. This is primarily because the NCDP does not define what other agencies will be implementing, and, therefore, it is difficult to define the resources that CHART will be required to provide for another agency's initiative.

2.4.4.1 Project Categories

To facilitate the development of deployment Projects for the CHART Non-constrained Plan, three Project category definitions have been developed. The notion behind this logical division of work is the expectation that each of these Project "categories", although interrelated, could be (and most probably would be) performed by different parties within CHART. In addition, they could be conducted independently for the most part, although the full capability/functionality would not be realized until all the related components are completed.

Field and Infrastructure Deployment

These Projects typically involve any or all of the following activities, depending on whether the deployment is for new sites or the replacement of devices at existing sites:

- Device site selection
- Site preparation
- Construction of supporting infrastructure or adaptation of existing infrastructure
- Device purchase
- Device installation

- Incident/emergency management equipment purchase

Integration and Communications

These Projects can involve any or all of the following activities, depending on whether the integration and communications are for new sites or replacement/upgrade of devices at existing sites:

- Provisioning the required communications to each device site (e.g., ordering leased circuits)
- Obtaining/procuring the necessary networking/system components
- Configuring the networking/system equipment upon receipt
- Installation of the networking/system equipment
- Configuring the CHART software to identify and accept/process data from each new or re-equipped device site
- Test and validation of communications, device functionality, and data transfer to/from each site

Software Development

These Projects involve developing the software required to support desired new functionality, including the deployment of new devices. Software development may require both modification and module development for the central CHART system software (e.g., database-related software, Graphical User Interface (GUI) software), as well as the development of device drivers and communications protocol modules for each new (i.e., not already supported by the CHART system) technology device that must be integrated into the central CHART system software.

2.4.4.2 Project Definitions

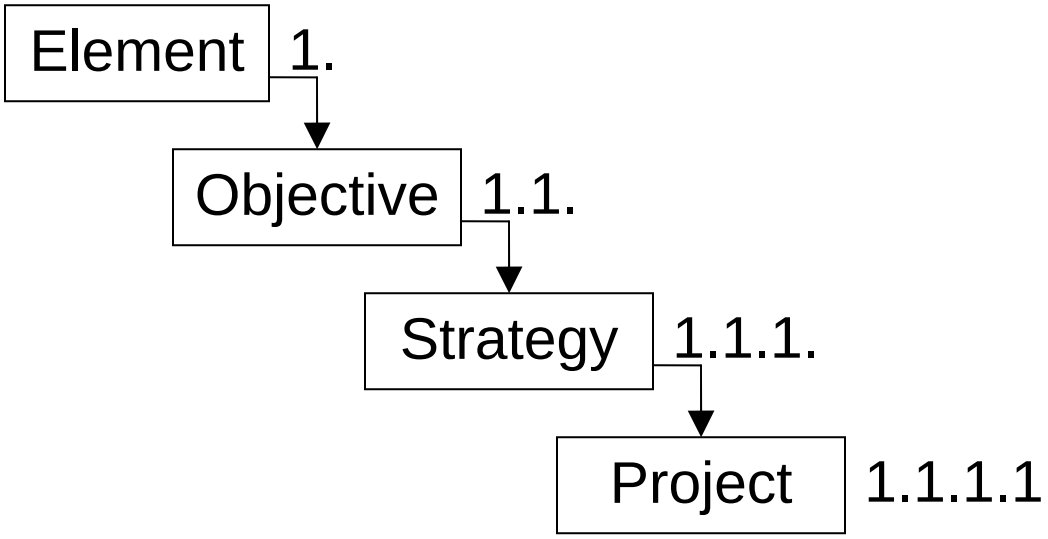
Each Project is defined using eight different fields, which include Project Description, Project Scale, Benefits, Technologies, Cost, Related Strategies, Cost Assumptions, and 2005 NCDP Reference. These definition fields aim to provide a uniform manner of explaining what the deployment Projects will entail, as well as its importance in fulfilling CHART's goals. The Project definitions and a further explanation of the five fields are included in Appendix D – Project Definitions.

2.4.5 Connectivity and Numbering

The numbering for the NCDP is consistent with that of other CHART planning initiatives in that it follows the Element (Goal in the Business Plan), Objective,

and Strategy hierarchy. Projects are defined in the NCDP as well as the CHART Deployment Plan, and are represented by the fourth series of numbers, as indicated in Figure 3 below.

Figure 3 - Non-constrained Deployment Plan Structure/Hierarchy



It should be noted that the NCDP numbering scheme permits each Objective to fall under multiple Elements. This structure allows each Objective to apply resources, or Strategies, that are associated with all six CHART functional Elements. This flexibility is significant because one of the primary aims of CHART is to integrate its various subsystems together to perform CHART operational functions.

For instance, the Objective of “enhancing CHART’s ability to manage traffic and increase safety near and within work zones and event locations” (Objective 13) will require deployments that stem from the Traffic and Roadway Monitoring Element to provide monitoring capabilities at events and work zones; the Traveler Information Element to deploy equipment for relaying information to those traveling at events or through work zones; as well as the Systems Integration and Communications Element in order to establish the necessary systems, software, and communications to accomplish the Objective.

2.4.6 Deployment Priority

Identifying the level of priority for defined deployments is a requirement for the NCDP. This requirement originates from the widespread need of decision-

makers and planners to gain a general understanding of what is most important to the CHART program. Defining priority within the NCDP is especially important because the Plan includes deployments that may only be feasible in a long-term timeframe. Associating a measure of priority to more distant deployments delineates those deployments that have an immediate importance for CHART implementation efforts.

The NCDP uses three levels of measurable priority to define the importance of each Strategy. These levels of priority are called "P-levels" and are denoted by a P-1, P-2, or P-3. The Support Strategies (i.e., where CHART is providing support to another agency's initiative) are denoted by an "S" to indicate the level of priority for that particular Support Strategy.

- P-1 & S-1: Functionality or deployment that needs to be put in place as soon as possible in order for CHART to achieve its overall operational vision and business model. CHART should currently be in the process of planning for or implementing the means to provide this operation or deployment.
- P-2 & S-2: Functionality or deployment that is critical for CHART to accomplish after P-1 priorities have been addressed in order for CHART to achieve its overall operational vision and business model. CHART should begin planning for the means to provide these functionalities or deployments as soon as possible.
- P-3 & S-3: Functionality or deployment that is within the overall CHART operational vision but will likely be included as part of future business models. CHART should treat these priorities as functionalities and deployments for future planning and deployment.

Table 5 provides the total number of Strategies per Priority "P-level" or "S-level", grouped by the six CHART Elements.

Table 5 – Number of Strategies per Priority Level, Grouped by Element

CHART Element	Priority-1 Strategies	Priority-2 Strategies	Priority-3 Strategies	Support-1 Strategies	Support-2 Strategies	Support-3 Strategies
Element 1 – Traffic and Roadway Monitoring	14	2	0	1	2	1
Element 2 – Incident Management	17	3	0	1	0	0
Element 3 – Traveler Information	13	2	3	2	0	0
Element 4 – Traffic Management	4	1	1	3	4	0
Element 5 – Systems Integration and Communication	33	0	2	3	0	0
Element 6 – Emergency and Weather Operations	7	1	0	4	1	0
Total Number of Strategies per Priority Level	88	9	6	14	7	1

2.5 Cost Estimates

Cost estimates were developed for the Projects (see Section 2.4.4 – Projects) included within the NCDP. These costs are intended to provide a "ballpark" figure of the funding required for CHART to build on its existing operations to reach the potential of defined Objectives and Strategies within this plan. Note that all cost estimates within the NCDP are in 2008 dollars, and not adjusted for inflation.

Additional funding – beyond what CHART currently receives – will be required not only for capital costs but also for preliminary studies and engineering prior to capital deployments, as well as operations and maintenance after deployment. The table below provides an overview of the total cost estimates associated with the Non-constrained Deployment Plan.

Table 6 – Total NCDP Cost Estimates

CHART NCDP Costs	Total Cost Estimate
Capital Cost	$299,949,000
Pre-deployment (Studies and Engineering) Costs	$29,994,900
20-year Operations and Maintenance Costs	$420,639,219
Total	$750,583,119.00

2.5.1 Capital Cost Estimates

Capital cost estimates are included within the 2008 NCDP and are defined for each Project (Appendix D – Project Definitions). Cost estimates were developed using the initial 2005 NCDP, along with the most current historical CHART expenditure data and available standard capital cost data and general ITS implementation knowledge. Deployment costs for the latest available technologies and other tools were assumed for developing the estimates. Also, capital costs are not adjusted for inflation experienced over the time it takes for actual deployment.

The NCDP cost estimates are based on assumptions that are recorded within each Project definition (Appendix D – Project Definitions). Most of these assumptions are made to compensate for unknown parameters associated with those implementations that will take place in the more distant future. Any significantly unproven ITS technologies that are still under development are not priced in the cost estimates if it was deemed that there is not a meaningful or accurate basis for doing so.

The NCDP only defines Strategies that necessitate capital spending, with the exception of the Support Strategies, which include staff resources and support that CHART will provide to other agencies' ITS initiatives (see Section 2.4.3 Strategies). CHART spending for other non-capital elements such as pre-deployment engineering studies, operations, and maintenance is estimated using percentage levels of capital spending, and discussed later in Sections 2.5.2 – Studies and Engineering Prior to Deployment, and 2.5.3 – Operations and Maintenance of Deployments. Funding necessary to carry out Support Strategies is not estimated because it is difficult to define the level of CHART resources required for deployment efforts initiated by other agencies.

The tables below present capital cost estimates in several different ways. Table 7 gives estimate subtotals grouped by Element and sub-grouped by Objective. Table 8 defines capital cost estimates grouped by Objective.

Table 7 – Total Capital Cost Estimates Grouped by Element

Element	Objective	Total Capital Cost Estimates
1 – Traffic and Roadway Monitoring (TRM)	1	$53,123,500
	2	$29,920,000
	3	$5,205,000
	13	$1,700,000
	16	$7,744,000
	17	$24,000
Element 1 – Subtotals:		$97,716,500
2 – Incident Management (IM)	5	$ 18,655,000
	6	$ 1,196,000
	16	$ 8,627,000
Element 2 – Subtotals:		$28,478,00
3 – Traveler Information (TI)	8	$33,075,000
	9	$35,975,000
	16	$7,621,000
Element 3 – Subtotals:		$76,671,000
4 – Traffic Management (TM)	11	$5,800,000
	16	$10,265,000
Element 4 – Subtotals:		$16,065,000
5 – Systems Integration and Communication (SIC)	1	$2,570,000
	3	$720,000
	6	$300,000
	8	$2,205,000
	10	$5,400,000
	12	$160,000
	13	$545,000
	14	$756,000
	16	$13,239,000
	17	$18,539,500
Element – 5 Subtotals:		$44,434,500

6 – Emergency and Weather Operations (EWO)	4	$16,125,000
	7	$14,859,000
	14	$5,600,000
Element – 6 Subtotals:		$36,584,000
NCDP Total Capital Cost Estimates		$299,949,000

Table 8 – Total Capital Cost Estimates Grouped by Objective

Number	Objective	Total Capital Cost Estimates
1	Enhance CHART's ability to visually monitor highway conditions.	$55,693,500
2	Enhance CHART's ability to collect automated traffic data from traffic detection sites.	$29,920,000
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data and reduced infrastructure requirements.	$5,925,000
4	Enhance CHART's ability to monitor travel conditions during inclement weather.	$16,125,000
5	Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	$18,655,000
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	$1,496,000
7	Enhance CHART's severe weather and emergency management operations.	$14,859,000
8	Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	$35,280,000
9	Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	$35,975,000
10	Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	$5,400,000

11	Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	$5,800,000
12	Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	$160,000
13	Enhance ability to manage traffic and increase safety near and within work zones and event locations.	$2,245,000
14	Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	$6,356,000
15	Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.	*
16	Develop additional capabilities within the CHART Operating System Software.	$47,496,000
17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	$18,563,500
NCDP Total Capital Cost Estimates		$299,949,000

* Objective 15 does not have a capital cost estimate because it only consists of Strategies in which CHART is acting in a supporting role to another agency initiative (see Section 2.4.3). In these supporting roles, CHART may incur little or no capital costs.

Table 9 provides total capital cost estimates for NCDP Projects grouped by one of the three Project categories. These categories – field and infrastructure deployment, integration and communications, and software development – are defined in Section 2.4.4.1 – Project Categories.

Table 9 – Total Capital Cost Estimates by Project Category

Number	Objective	Project Category		
		Field and Infrastructure Deployment Cost	Integration and Communications Cost	Software Development Cost
1	Enhance CHART's ability to visually monitor highway conditions.	$53,123,500	$1,720,000	$850,000
2	Enhance CHART's ability to collect automated traffic data from traffic detection sites.	$29,920,000	$-	$-
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data, and reduced infrastructure requirements.	$5,205,000	$720,000	$-
4	Enhance CHART's ability to monitor travel conditions during inclement weather.	$16,125,000	$-	$-
5	Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	$18,655,000	$-	$-
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	$1,496,000	$-	$-
7	Enhance CHART's severe weather and emergency management operations.	$14,859,000	$-	$-
8	Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	$34,025,000	$705,000	$550,000
9	Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	$35,975,000	$-	$-
10	Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	$-	$5,400,000	$-
11	Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	$5,800,000	$-	$-
12	Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	$-	$160,000	$-
13	Enhance ability to manage traffic and increase safety near and within work zones and event locations.	$2,200,000	$45,000	$-

Number	Objective	Project Category		
		Field and Infrastructure Deployment Cost	Integration and Communications Cost	Software Development Cost
14	Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	$6,356,000	$-	$-
15	Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.	$-	$-	$-
16	Develop additional capabilities within the CHART Operating System Software.	$-	$1,478,000	$46,018,000
17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	$590,000	$17,973,500	$-
NCDP Total Capital Cost Estimates		$224,329,500	$28,201,500	$47,418,000

* Objective 15 does not have a capital cost estimate because it only consists of Strategies in which CHART is acting in a supporting role to another agency initiative (see Section 2.4.3). In these supporting roles, CHART may incur little or no capital costs.

2.5.2 Studies and Engineering Prior to Deployment

The CHART program must consistently take into account the activities and associated resources required to take place before ITS project implementation. That is, the success of a deployment will depend heavily upon the analyses, studies, and engineering reports to determine: 1) if the deployment is, in fact, feasible and beneficial; 2) what exactly to deploy (e.g., type of technology, extent, location); and 3) the best manner in which to carry out the deployment. Because the services to provide planning studies and engineering are not capital costs in the sense of placing a new piece of equipment in the field, they are defined within this Plan as an estimated percentage of capital costs.

Table 10 is a cost estimate for the pre-deployment (studies and engineering) activities required for those capital deployments within this plan. These figures are based on using an estimated 10% of the capital costs estimated for the Projects defined within the NCDP. The 10% estimate is a figure historically used throughout the ITS arena, as well as within the CHART Program, to estimate studies and engineering costs.

Table 10 – Pre-Deployment (Studies & Engineering) Cost Estimates per Element

Element	Pre-Deployment Cost Estimates
Element 1 – Traffic and Roadway Monitoring	$9,771,650
Element 2 – Incident Management	$2,847,800
Element 3 – Traveler Information	$7,667,100
Element 4 – Traffic Management	$1,606,500
Element 5 – Systems Integration and Communication	$4,443,450
Element 6 – Emergency and Weather Operations	$3,658,400
NCDP Total Pre-Deployment Cost Estimate	$29,994,900

2.5.3 Operations and Maintenance of Deployments

Another critical factor in developing a successful ITS program is a strong commitment to efficiently operate and maintain the field devices, system components, communications network, and software that are deployed. For purposes of the NCDP, operations and maintenance (O&M) costs have been determined as an estimated percentage of capital costs.

The operations and maintenance cost estimates within the NCDP are for the use and upkeep of future deployments defined in this Plan, and, therefore, do not include CHART's current expenditures for operations and maintenance. It is important to note that the funding classifications included under the "ITS maintenance" umbrella are commonly debated. As such, there is general uncertainty in whether capital spending for replacing and upgrading malfunctioning/outdated system components should be categorized as a maintenance function. However, for the purposes of this Plan, replacing and upgrading ITS components are treated as a separate capital deployment and have associated Strategies and Projects.

Also for the purposes of this plan, maintenance costs for those Projects in the software development category are defined as a percentage of the original development to provide intermittent "fixes" to initial software. This estimate does not include true software "enhancements", which would require significant programming to add software functionality, and are thus considered a separate deployment Project.

The operations and maintenance for those deployments in the field and infrastructure, and integration and communication Project categories are estimated as general systems operations and maintenance. The following

expenditures are included in the system operations and maintenance cost estimates:

- Management staff hours – full-time labor to manage day-to-day program activities/initiatives, contracts, in-house planning and technical studies, operational/maintenance staff, public outreach, training, coordination with other agencies, and general program decision-making
- Operational staff hours – full/part-time and on-call labor to control, configure, provide security, administer, and troubleshoot systems/software/communications electronics and hardware; undergo training; provide patrolling and incident management services along highways; perform other administrative program/office functions
- Maintenance staff hours – full/part-time and on-call CHART labor or contracted labor to troubleshoot, repair, run diagnostics on, and generally perform upkeep on CHART field devices and system components
- Operational expenses – costs related to day-to-day running of facilities and systems, including building use costs, monthly phone and power, and leased communication lines
- Maintenance expenses/equipment – costs to supply spare parts, vehicles, equipment, and tools needed to repair CHART field devices and systems components

Table 11 below presents estimates for operations and maintenance, as it would be carried out over a projected 20-year deployment period. As previously stated, cost estimates were separated for the different Project categories because operations and maintenance percentages of capital costs will be different for each. Field and infrastructure deployments, integration and communications deployments, and software deployments are based on a 15%, 15%, and 4.6% (respectively) estimate of total capital cost projections.

Based on information collected throughout the ITS arena, a system operations and maintenance cost of 15% of CHART's capital expenditures is considered appropriate. While this figure could be on the high side, it enables decision-makers to know with greater certainty that the O&M estimates are not under-represented, as is often the case. A 4.6% software cost estimate is based on documented software support estimates for fixing errors to originally developed software (FHWA ITS Joint Program Office – The Road to Successful ITS Software Acquisition, Volume II).

Operations and maintenance cost estimates were derived using an incremental calculation of how the CHART program might implement the deployments defined in this Plan over 20 years. (Note: The 20 years is not meant to be a constraining timeframe for the plan, but was used as a basis for determining costs.) The calculation assumes that CHART will build deployments in each year

amounting to one twentieth of the total capital costs estimated for Projects over the full 20-year period. The estimate then takes into account that CHART will need to continue operating and maintaining the deployments that were built in previous years at a rate of 15% of the original capital deployment cost. Thus, each yearly operations and maintenance cost is figured in increments up to the 20th year, and then totaled for each Project category, as shown in Table 11 below,.

Table 11 – Capital and 20-year Operations and Maintenance Cost Estimates per Project Category, Grouped by Objective

Number	Objective	Capital / O&M	Project Category		
			Field and Infrastructure Deployment	Integration and Communications	Software Development
1	Enhance CHART's ability to visually monitor highway conditions.	Capital Cost	$53,123,500	$1,720,000	$850,000
		20-Year O&M Cost	$83,669,513	$2,709,000	$410,550
2	Enhance CHART's ability to collect automated traffic data from traffic detection sites.	Capital Cost	$29,920,000	-	-
		20-Year O&M Cost	$47,124,000	-	-
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data, and reduced infrastructure requirements.	Capital Cost	$5,205,000	$720,000	-
		20-Year O&M Cost	$8,197,875	$1,134,000	-
4	Enhance CHART's ability to monitor travel conditions during inclement weather.	Capital Cost	$16,125,000	-	-
		20-Year O&M Cost	$25,396,875	-	-
5	Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	Capital Cost	$18,655,000	-	-
		20-Year O&M Cost	$29,381,625	-	-
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	Capital Cost	$1,496,000	-	-
		20-Year O&M Cost	$2,356,200	-	-
7	Enhance CHART's severe weather and emergency management operations.	Capital Cost	$14,859,000	-	-
		20-Year O&M Cost	$23,402,925	-	-
8	Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	Capital Cost	$34,025,000	$705,000	$550,000
		20-Year O&M Cost	$53,589,375	$1,110,375	$265,650
9	Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	Capital Cost	$35,975,000	-	-
		20-Year O&M Cost	$56,660,625	-	-

Number	Objective	Capital / O&M	Project Category		
			Field and Infrastructure Deployment	Integration and Communications	Software Development
10	Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	Capital Cost	$18,900,000	$5,400,000	-
		20-Year O&M Cost	-	$8,505,000	-
11	Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	Capital Cost	$5,800,000	-	-
		20-Year O&M Cost	$9,135,000	-	-
12	Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	Capital Cost	-	$160,000	-
		20-Year O&M Cost	-	$252,000	-
13	Enhance ability to manage traffic and increase safety near and within work zones and event locations.	Capital Cost	$2,200,000	$45,000	-
		20-Year O&M Cost	$3,465,000	$70,875	-
14	Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	Capital Cost	$6,356,000	-	-
		20-Year O&M Cost	$10,010,700	-	-
15	Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.	Capital Cost	*	*	*
		20-Year O&M Cost	*	*	*
16	Develop additional capabilities within the CHART Operating System Software.	Capital Cost	-	$1,478,000	$46,018,000
		20-Year O&M Cost	-	$2,327,850	$22,226,694
17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	Capital Cost	$590,000	$17,973,500	-
		20-Year O&M Cost	$929,250	$28,308,263	-
NCDP Total Capital and 20-Year O&M Cost Estimates		Capital Cost	$224,329,500	$28,201,500	$47,418,000
		20-Year O&M Cost	$353,318,963	$44,417,363	$22,902,894

* Objective 15 does not have a capital cost estimate because it only consists of Strategies in which CHART is acting in a supporting role to another agency initiative (see Section 2.4.3). In these supporting roles, CHART may incur little or no capital costs.

3. Strategies and Projects

While the previous sections were developed to provide a fundamental background on the document, this section gives more detail in the form of ITS Strategy descriptions and Project planning. However, the greatest detail is contained within Appendix D – Project Definitions. It gives a detailed description of those Projects named in Section 3.2 that will be required to achieve the Strategies within Section 3.1.

3.1 Strategies Grouped by Objective

Table 12 presents the CHART NCDP Strategies in their entirety, with associated priorities – designated as a 1, 2, or 3 (1 being highest priority). Support Strategies are designated by an "S" in the priority column. Grouping the Strategies by Objectives will associate the Strategies with a more specific purpose for carrying out the ITS deployment it prescribes rather than grouping them by Element at a more general level. Those readers interested in seeing Strategies grouped by Element should review Appendix B – Strategies Grouped by Element.

Table 12 – CHART Strategy Definitions and Priority, Grouped by Objective

Objective		Element	Strategy		Priority
1	Enhance CHART's ability to visually monitor highway conditions.	1 - TRM	1.1.1	*Additional Closed-Circuit Television (CCTV)* – Deploy CCTV cameras along major state highways in the Baltimore and Washington D.C. regions to provide full visibility of roadways. Continue to extend CCTV camera coverage statewide to include all major state highways, as well as evacuation and Freeway Incident Traffic Management (FITM) routes.	*1*
			1.1.2	*Upgrade Existing Closed-Circuit Television (CCTV)* – Upgrade the technology of existing CCTV infrastructure to continue CHART's ability to effectively monitor roadway conditions by using the latest technological developments.	*2*
			1.1.3	*Traffic Monitoring at Video Detection Sites* – Deploy roadside infrastructure to enable CHART to access data and images from video detection cameras at signalized intersections.	*1*
			1.1.4	*Incident Monitoring Cameras on Emergency Response Vehicles* – Deploy camera image or video capture technology on CHART Emergency Response Vehicles to provide near real-time monitoring of field conditions (This Strategy is repeated under Objective 6 as Strategy 2.6.5).	*1*
		5 - SIC	5.1.1	*Process Video Images for Traffic Information* – Develop "machine vision" technology to facilitate the collection of traditional video detection data (speed, volume, and occupancy), as well as data associated with visual detection of incidents.	*1*
			5.1.2	*Aerial Monitoring* – Identify and implement strategies which will provide CHART access to video images from cameras on airplanes and helicopters operated by various agencies in the Baltimore region, and extend aerial monitoring coverage to the Washington D.C., Frederick, and Annapolis regions.	*3*
2	Enhance CHART's ability to collect automated traffic data from traffic detection sites.	1-TRM	1.2.1	*Additional Roadside Traffic Detectors* – Deploy new detection sites along major state highways in the Baltimore/Washington D.C. regions to provide full detection at 1-mile spacing of roadways. Continue to extend roadside traffic detection coverage statewide to include major state highways as well as designated evacuation and Freeway Incident Traffic Management (FITM) routes.	*1*
			1.2.2	*Support for Deployment of Vehicle Passenger Occupancy and Class Determination Detectors* – Support the deployment of detection devices along freeways and expressways with the capability to determine vehicle class types (car, truck type) and a vehicle's passenger occupancy (HOV) in order to provide data for various operations.	*S-3*

Objective		Element	Strategy		Priority
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data, and reduced infrastructure requirements.	1-TRM	1.3.1	*Portable Trailer-mounted Traffic Monitoring Cameras* – Obtain portable camera trailers with wireless communications in order to provide flexible monitoring capabilities at any location. (This Strategy is repeated under Objective 13 as Strategy 1.13.2.)	*1*
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data and reduced infrastructure requirements.	1-TRM	1.3.2	*Portable Trailer-Mounted Traffic Detectors* - Obtain portable traffic detection trailers with wireless communications, as well as intrusion detection devices, in order to provide flexible safety monitoring, traffic data collection, and queue detection at any location. (This Strategy is repeated under Objective 13 as Strategy 1.13.3.)	*1*
			1.3.3	*Traffic Probe Data Collection* – deploy necessary infrastructure – either directly or through partnerships with public or private agencies – to support the collection of traffic probe data through use of various technologies in order to determine traffic flow conditions along freeways and expressways.	*1*
			1.3.4	*Toll Tags as Traffic Probes* – Deploy infrastructure to collect and process data from vehicle toll tags along state freeways and expressways in order to determine travel times and traffic flow conditions.	*2*
			1.3.5	*Support Deployment of Traffic Probe Devices in MDOT Vehicles – Support other agencies in* equipping vehicles owned by Maryland Department of Transportation Modals with technology applications that allow traffic flow data to be collected while traveling along roadways.	*S-1*
		5 - SIC	5.3.1	*Integrate Traffic Probe Data* – Collect and integrate probe data collected by various technology applications in order to determine traffic flow conditions along freeways and expressways.	*1*
4	Enhance CHART's ability to monitor travel conditions during inclement weather.	6-EWO	6.4.1	*Additional Weather Stations* – Deploy infrastructure at new weather and pavement condition monitoring sites to provide thorough statewide coverage.	*1*
			6.4.2	*Road Surface Monitoring Equipment on MDSHA Vehicles* – Equip Maryland State Highway Administration snowplows with technology applications that collect and transmit road surface condition data as the vehicle travels	*2*
			6.4.3	*Automatic Vehicle Location (AVL) on Snowplow Vehicles* – Equip Maryland State Highway Administration snowplows with AVL devices to collect and transmit vehicle location data to support more efficient management of roadway treatment winter operations.	*1*

Objective		Element	Strategy		Priority
5	Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	2 – IM	2.5.1	*CHART Incident Management Field Equipment* – Continue to purchase the most advanced field equipment (including vehicles, clearance machinery, etc.) to enhance CHART incident management personnel's ability to detect, respond, and clear incidents and emergencies along state highways in all jurisdictions.	*1*
			2.5.2	*Public Safety Incident Management Equipment* – Provide and transfer equipment to Maryland State Police and other public safety agencies to improve coordination and joint activities with CHART.	*1*
			2.5.3	*Incident/Emergency Management Training* – Train personnel, both within the CHART Program and from other agencies, to familiarize operational and technical staff with the underlying principals of incident/emergency management, ITS applications, and the impacts of congested roadways.	*1*
			2.5.4	*Extend CHART Traffic Patrol* – Extend CHART traffic patrol program to include coverage in every MDSHA Engineering District.	*1*
			2.5.5	*Increase Existing CHART Traffic Patrol Coverage* – Expand the CHART traffic patrol program to increase existing coverage in the Baltimore and Washington, D.C. regions to 24x7 coverage.	*1*
			2.5.6	*CHART Vehicle Depots* – Build CHART vehicle depots in the Baltimore and Washington, D.C. areas to facilitate vehicle management and maintenance.	*1*
			2.5.7	*CHART Traffic Operations Center (TOC) Expansion* – Extend CHART operational coverage to include deployment of a TOC in every MDSHA Engineering District.	*1*
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	2 – IM	2.6.1	*Automated Vehicle Location (AVL)* on MDSHA Incident/Emergency Vehicles – Deploy Global Positioning System (GPS)-based AVL devices and systems to collect MDSHA incident/emergency vehicle location data, in order to more efficiently manage MDSHA field resources during incidents and emergencies.	*1*
			2.6.2	*Support for Opening Local Operations Centers* – Support counties and municipalities in their efforts to establish regional ITS programs and operations centers with functions that will be integrated inter-regionally with the CHART SOC.	*S-1*

Objective		Element	Strategy		Priority
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	2 – IM	2.6.3	*Real-time Data Acquisition Devices* – Equip operational personnel with portable devices that will be used to gather real-time information on CHART field operations.	*1*
			2.6.4	*Wireless Real-time Data Sharing Devices* – Equip remote incident management personnel with portable devices to support the exchange of messages and information to facilitate incident/emergency management field operations.	*1*
			2.6.5	*Incident Monitoring Cameras on CHART Emergency Response Vehicles* – Deploy camera image or video capture technology on CHART Emergency Response Vehicles to provide near real-time monitoring of field conditions (This Strategy is repeated under Objective 1 as Strategy 1.1.4).	*1*
		5 – SIC	5.6.1	*Support Regional Interoperable Incident Management Voice Communications* – Participate in the development of systems and software to establish interoperability between various agencies' voice communication systems to provide uniform communications between incident/emergency response personnel throughout a particular region.	*S-1*
			5.6.2	*Support Regional Incident Management Communication Networks* – Participate in the development and deployment of regional communication networks that access various public safety and transportation management databases, as well as provide real-time messaging capabilities between remote incident/emergency response personnel, in order to facilitate coordination and communications among various agencies responding to incidents and emergencies.	*S-1*
			5.6.3	*Support Integration of Regional Incident Management Systems* – Participate in the development and implementation of regional incident/emergency management networks that integrate independent agency systems in order to more efficiently manage various operations related to the detection, response, and clearance of incidents and emergencies throughout a region.	*S-1*
			5.6.4	*Geo-location Devices on Portable Incident/Emergency Management Equipment* – Equip MDSHA and other agencies' portable field equipment (including device trailers, tow trucks, incident management equipment, and FITM trailers) with geo-location devices in order to dynamically track and update exact locations and current usage status (e.g., direction facing) of field equipment being used for response to incidents/emergencies.	*1*

Objective		Element	Strategy		Priority
7	Enhance CHART's severe weather and emergency management operations.	6– EWO	6.7.1	*Traffic Monitoring Infrastructure Along Evacuation Routes* – Deploy permanent traffic detection and visual monitoring devices along evacuation routes in order to improve CHART operations during severe weather and emergency situations.	*1*
			6.7.2	*Support the Deployment of Bio-hazard/Radiological Detection Devices* – Support for deploying field devices along identified stretches of roadways and/or on critical infrastructure to detect biohazards or abnormal radiation levels and automatically warn CHART and other appropriate agency personnel.	*S-1*
			6.7.3	*Support for Emergency Operations Coordination* – Participate in coordination among transportation and public safety agencies to formulate emergency operations plans that would detail CHART's responsibilities for emergency response operations at the state or national levels. Coordination efforts would include CHART's connectivity with various emergency communication systems that provide a secure means of coordination and communications among responding agencies.	*S-1*
			6.7.4	*Traffic Management Infrastructure for Emergency Operations* – Deploy permanent infrastructure along evacuation routes (e.g., reversible lane signals, and route guidance signs) that will manage increased volumes of traffic using various technology applications.	*1*
			6.7.5	*Satellite Voice Communications for Field Emergency Operations* - Equip remote incident management personnel with portable satellite voice communication units to support redundant and continuous voice communications between field personnel and CHART operations centers during emergency situations.	*1*

Objective		Element	Strategy		Priority
8	Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	3 – TI	3.8.1	*CHART Web Site Enhancements/Development* – Enhance the functionality and traveler information services provided to the public through "CHART on the Web".	*1*
			3.8.2	*Support Regional Advanced Traveler Information Programs* –Support regional programs that manage various sources of transportation data in order to provide a "one-stop shopping" source for the public to access multi-modal traveler information through various media.	*S-1*
			3.8.3	*Support Information Service Provider Partnerships* – Support for partnerships with ISPs, which manage and/or fuse transportation data, and distribute traveler information through various dissemination media.	*S-1*
			3.8.4	*Electronic Traveler Information Board* – Install display units to provide real-time traffic and transportation information at various locations. Such as rest areas, airports, Motor Vehicle Administration (MVA) facilities, and transit transfer points.	*2*
			3.8.5	*AM/FM Side-Band Traffic Alerts* – Deploy necessary infrastructure to provide CHART the ability to broadcast traveler information over AM/FM frequencies using technology that transmits data to vehicles equipped with receivers.	*3*
			3.8.6	*Commercial Radio Station(s) to Broadcast Regional Travel Information* – Purchase commercial radio stations within various regions in order to provide travelers with a dedicated, high-quality, and reliable source for up-to-date regional traveler information.	*1*
		5 – SIC	5.8.1	*Statewide 511 Service* – Deploy necessary systems components to initiate a statewide 511 program that collects and manages available transportation-related data throughout the state and distributes information to travelers calling within the state using technologies such as audio-text and voice recognition.	*1*

Objective		Element	Strategy		Priority
9	Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	3 – TI	3.9.1	*Additional Dynamic Message Signs (DMS)* – Deploy Dynamic Message Signs along major state highways in the Baltimore and Washington, D.C. regions to provide comprehensive traveler information on roadways. Continue to extend DMS coverage statewide to include major state highways, as well as evacuation and Freeway Incident Traffic Management (FITM) routes.	*1*
			3.9.2	*Additional Highway Advisory Radio (HAR)* – Deploy Highway Advisory Radios along major state highways in the Baltimore and Washington, D.C. regions to provide comprehensive traveler information on roadways. Continue to extend HAR coverage statewide to include major state highways, as well as evacuation and Freeway Incident Traffic Management (FITM) routes.	*2*
			3.9.3	*Replace and Upgrade Highway Advisory Radio (HAR)* – Update the technology in existing highway advisory radio infrastructure to assure that this service continues to effectively broadcast current traveler information.	*1*
			3.9.4	*Replace and Upgrade Portable Trailer-mounted Dynamic Message Signs (DMS)* – Replace and upgrade existing portable DMS trailers with the latest technologies and wireless communications in order to provide flexible distribution of traveler information at any location. (This Strategy is repeated under Objective 13 as Strategy 3.13.1.)	*1*
			3.9.5	*Replace and Upgrade Portable Trailer-mounted Highway Advisory Radios (HAR)* – Replace and upgrade existing portable HAR trailers with the latest technologies and wireless communications in order to provide flexible distribution of traveler information at any location. (This Strategy is repeated under Objective 13 as Strategy 3.13.2)	*1*
			3.9.6	*Infrastructure to Support In-vehicle Highway Hazard Alerts* – Deploy roadside detectors and short-range communication infrastructure to detect hazardous traveling conditions and exchange communications with traveling vehicles to alert motorists that will be affected.	*3*
			3.9.7	*Infrastructure to Support In-vehicle Highway Signage Systems* – Deploy short-range communication infrastructure to transmit data to a traveling vehicle in order to allow the motorist to see an in-vehicle display of upcoming static and dynamic signs, as well as other messages pertaining to motorist needs.	*3*

Objective		Element	Strategy		Priority
10	Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	4 – TM	4.10.1	*Support Statewide Traffic Signal System Optimization* – Support the development of a signal optimization plan and the deployment of new timings for signal systems operating on MDSHA controlled arterials throughout the state in order to increase traffic flow.	S-1
		5 – SIC	5.10.1	*Integrate Traffic Signal System Data* – Integrate the operation of traffic signal systems with SOC operations to automatically employ pre-arranged incident/emergency management timing plans for optimal traffic flow during incidents and emergencies, especially along Freeway Incident Traffic Management (FITM) routes.	1
11	Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	4 – TM	4.11.1	*Support Deployment of Ramp Metering* – Support the deployment of infrastructure to meter traffic flow onto freeways and expressways at access ramps in order to control the freeway's or expressway's operational level of service.	S-2
			4.11.2	*Support Deployment of Variable Speed Limit Systems* – Support the deployment of roadside devices along freeways and expressways that display changeable speed limits that are controlled by the CHART Operating System, in order to better control the freeway's or expressway's operational level of service.	S-2
			4.11.3	*Support Deployment of Lane Control Systems* – Support the deployment of various technologies that control the flow of traffic along freeways and expressways, including counter-flow lane control systems and dynamic HOV lanes, in order to better control the operational level of service.	S-2
			4.11.4	*Support Deployment of Queue Detection and Warning Systems* – Support the deployment of infrastructure to collect data in order to detect traffic queues at locations prone to congestion along freeways and expressways, and automatically warn motorists who will be affected.	S-1
			4.11.5	*Trail Blaze Signage* – Deploy infrastructure to provide signage to route vehicles along Freeway Incident Traffic Management (FITM) routes, or other pre-established diversion routes.	1
			4.11.6	*Highway Access Alert Systems* – Deploy infrastructure to alert motorists of travel conditions before reaching freeway or expressway access ramps.	3
			4.11.7	*Support Deployment of Dynamic Toll Lanes* – Participate in the establishment and operation of High Occupancy Toll (HOT) lanes and other advanced toll lane operations that dynamically toll travelers depending on various parameters (e.g., current congestion level and number of passengers in a vehicle) in order to better manage travel demand and traffic flow.	S-1

Objective		Element	Strategy		Priority
12	Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	1 – TRM	1.12.1	*Support Partnerships to Monitor Parking Facilities* – Develop partnerships to monitor parking capacity and other operations at major public parking facilities as well as at recurring event locations, Park 'n' Ride locations, and airports.	*S-2*
		4 – TM	4.12.1	*Support for Deployment of Traffic Management Infrastructure at Inter-modal Transfer Points and Major Parking Facilities* – Develop partnerships and deploy infrastructure to manage traffic flow as well as display real-time information at and approaching major parking facilities, including event parking and Park 'n' Ride facilities, in order to guide motorists to available parking.	*S-1*
		5 – SIC	5.12.1	*Integrate Parking Management Data* – Collect and integrate parking management data from public and private parking institutions in order to improve parking traffic management operations through the CHART Operating System.	*1*

Objective		Element	Strategy		Priority
13	Enhance ability to manage traffic and increase safety near and within work zones and event locations.	1 – TRM	1.13.1	*Work Zone/Event Traffic Monitoring Infrastructure* – Where applicable, deploy permanent infrastructure to support traffic flow detection and video monitoring capabilities at work zones (for continued coverage after completion of construction) and major event locations.	*1*
			1.13.2	*Portable Trailer-mounted Traffic Monitoring Cameras* - Obtain portable camera trailers with wireless communications in order to provide flexible monitoring capabilities at work zones and event locations. (This Strategy is repeated under Objective 3 as Strategy 1.3.1.)	*1*
			1.13.3	*Portable Trailer-mounted Traffic Detectors* - Obtain portable traffic detection trailers with wireless communications, as well as intrusion detection devices, in order to provide flexible safety monitoring, traffic data collection, and queue detection at work zones and event locations. (This Strategy is repeated under Objective 3 as Strategy 1.3.2.)	*1*
		3 – TI	3.13.1	*Replace and Upgrade Portable Trailer-mounted Dynamic Message Signs* (DMS) – Replace and upgrade existing portable DMS trailers with the latest technologies and wireless communications in order to provide traveler information messages at work zone and event locations. (This Strategy is repeated under Objective 9 Strategy 3.9.4)	*1*
			3.13.2	*Replace and Upgrade Portable Trailer-mounted Highway Advisory Radios* (HAR) – Replace and upgrade existing portable HAR trailers with the latest technologies and wireless communications in order to broadcast traveler information messages within work zone and event areas. (This Strategy is repeated under Objective 9 as Strategy 3.9.5)	*1*
		5 – SIC	5.13.1	*Geo-location Devices on Portable Work Zone/Event Equipment* – Equip MDSHA and other agencies' portable work zone/event equipment with geo-location devices in order to dynamically track and update exact locations and current usage status (e.g., direction facing) of field equipment being used for work zone or event management.	*1*
			5.13.2	*Geo-location Technology for Locating Work Zone Operations* – Deploy geo-location devices that will provide exact locations of work zone limits and other information to be integrated into the CHART Operating System for dynamic mapping purposes. Establish standardized methods for construction contractors to utilize geo-location equipment.	*3*

Objective		Element	Strategy		Priority
14	Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	5 – SIC	5.14.1	*Security Measures for CHART Operations Centers and System Infrastructure* – Deploy infrastructure and systems applications that protect against unauthorized access to the CHART network, and user controls within operation center facilities.	*1*
		6 – EWO	6.14.1	*Security Monitoring Equipment for CHART Devices* – Continue to deploy infrastructure and equipment to increase security for CHART field equipment that is accessible to the public and is essential to continuity of CHART operations.	*1*
			6.14.2	*Security Monitoring Equipment for Critical Transportation Infrastructure* – Deploy technology applications that monitor identified critical transportation infrastructure to increase security measures in order to protect against sabotage and destruction.	*1*
15	Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.	1 – TRM	1.15.1	*Support for Highway-rail Crossing Monitoring Devices* – Support the deployment of devices that detect both automobiles and approaching trains at highway-rail crossings to support various safety alert systems, as well as traffic management systems.	*S-2*
		4 – TM	4.15.1	*Support for Highway-rail Crossing Safety and Diversion Systems* – Support the deployment of infrastructure to process detection data at identified highway rail crossings and use technology applications to divert approaching traffic, as well as to predict collisions and alert motorists and/or train operators accordingly.	*S-2*
		6 - EWO	6.15.1	*Support for Deployment of Flood Monitor and Warning Systems* – Deploy technology applications at locations identified as prone to flooding, in order to monitor flooding effects on road surface conditions and warn motorists of potential hazards.	*S-2*
			6.15.2	*Support for Deployment of Fog Monitor and Warning Systems* – Deploy technology applications at locations identified as hazardous due to recurring fog conditions, in order to monitor fog effects on traveling conditions and warn motorists of potential hazards.	*S-1*
			6.15.3	*Support for Deployment of High Wind Monitor and Warning Systems* – Deploy technology applications at locations identified as hazardous due to high wind conditions, in order to monitor high wind effects on traveling conditions and warn motorists of potential hazards.	*S-1*

Objective		Element	Strategy		Priority
16	Develop additional capabilities within the CHART Operating System Software.	1 – TRM	1.16.1	*Exchange Closed-Circuit Television Images and Camera Control* – Software module deployment for collecting and integrating video images and camera control interfaces from sources outside of CHART, as well as providing CHART camera images and administered control to outside agencies.	*1*
			1.16.2	*Exchange and Integrate Traffic Monitoring Data with Other Agencies* – Software module deployment for processing traffic monitoring and detection data from CHART devices and sending it to other agencies, as well as receiving and integrating traffic monitoring data from outside sources and integrating it into the CHART Operating System.	*1*
			1.16.3	*Develop Traffic and Roadway Monitoring Software* – Software module deployment to provide added functionality to traffic and roadway monitoring operations within CHART software.	*1*
		2 – IM	2.16.1	*Integrate Emergency Notification Data from MAYDAY Systems* – Software module deployment to collect and integrate MAYDAY notification data from outside systems into the CHART Operating System to facilitate incident/emergency management operations that accurately locate and verify incidents and emergencies through a common map interface.	*2*
			2.16.2	*Develop Incident/Emergency Management and Computer Aided Dispatch (CAD) Central Software* – Software module deployment to develop the central CHART system software to process operations data from multi-jurisdictional public safety and transportation-related agencies responsible for incident/emergency detection, verification, response, and clearance in order to optimize MDSHA incident/emergency management and dispatch operations throughout the state.	*1*
			2.16.3	*Develop Incident Prediction Software* – Software module deployment that uses various sources of data as input into an algorithm that processes predictions and probabilities for incidents occurring along stretches of highways where data is being collected.	*2*
			2.16.4	*Develop Incident/Emergency Notification Software* – Software module deployment that generates an automated response by notifying the most appropriate agencies based on processed data defining the incident/emergency parameters, as well as processed data on real-time status of resources available to respond to the incident/emergency.	*1*
			2.16.5	*Integrate Incident Location Data from Wireless Enhanced 911 and #77 Systems* – Software module deployment to collect and integrate geo-location data from 911 and #77 callers into CHART software applications in order to accurately locate and verify incidents/emergencies through a common map interface.	*1*
			2.16.6	*Provide Travel Condition Data to Public Safety and Transportation Agencies* – Software module deployment that generates an automated response by processing requests from agencies responding to a particular incident/emergency in order to provide real-time travel conditions for the given travel route.	*1*

Objective		Element	Strategy		Priority
16	Develop additional capabilities within the CHART Operating System Software.	2 – IM	2.16.7	*Multi-modal Incident/Emergency Information Clearinghouse* – Software module deployment to collect and integrate incident/emergency data from multi-modal agencies into the CHART Operating System, as well as to process requests for multi-modal incident/emergency data and distribute it to various sources in a standard format.	*1*
			2.16.8	*Integrate Incident/Emergency Rail System Data* – Software module deployment to collect and integrate incident/emergency data from various Rail Carrier Systems into the CHART Operating System in order to improve incident detection and traffic management at and around highway-rail crossings.	*2*
			2.16.9	*Integrate Incident Monitoring Cameras on CHART Emergency Response Vehicles* – Software module/enhancement to support the integration and distribution of CHART Emergency Response Vehicle video throughout the CHART Operating System.	*1*
		3 – TI	3.16.1	*Multi-modal Traveler Information Data Repository/Clearinghouse* – Develop a data repository/clearinghouse for CHART to make traveler information equally and readily available to any appropriate external organization desiring access (e.g., media and other private dissemination agencies).	*1*
			3.16.2	*Provide Data to support "Personal Subscription Services" for Traveler Information* – Develop public / private partnerships to process and package traveler information that is personalized using various technologies to identify the particular traveler and their predefined travel characteristics, such as routes, origins, destinations, and preferred modes.	*1*
			3.16.3	*Exchange/Integrate Multi-modal Data with/from Private Information Service Providers (ISPs)* – Software module deployment to request and integrate multi-modal traveler information data from a private traveler information clearinghouse or ISP, as well as to process multi-modal traveler information data into a pre-determined format for transfer to a private traveler information clearinghouse or ISP.	*1*
			3.16.4	*Exchange/Integrate Traveler Information Data with/from Other Public Agencies* – Software module deployment to request multi-modal traveler information data from various public agencies (within and outside of Maryland) and integrate it into the CHART system, as well as to collect and process multi-modal traveler information data within the CHART system into a pre-determined format for transfer to another public agency's system.	*1*
			3.16.5	*Develop Traveler Information Software* - Software module deployment to provide added functionality to traveler information distribution and management capabilities within CHART central software.	*1*

Objective		Element	Strategy		Priority
16	Develop additional capabilities within the CHART Operating System Software.	4 – TM	4.16.1	*Integrate Arterial Traffic Management Data* – Software module deployment to integrate available principal arterial traffic data into the CHART Operating System for use in traffic management and various other operations.	1
			4.16.2	*Develop Software to Manage Arterial Traffic* – Software module deployment to develop CHART's ability to control field devices in order to manage traffic along principal arterials (especially along FITM routes), and at principal arterial intersections with freeways and expressways.	2
			4.16.3	*Develop Traffic Management Software* – Software module deployment to provide added functionality to freeway and expressway traffic management operations within CHART central software.	1
		5 – SIC	5.16.1	*Develop Software to Provide Transportation Network Simulation and Prediction Capabilities* – Utilize simulation algorithms to analyze real-time traffic conditions and predict likely impacts on traffic flows as an operational decision tool.	1
			5.16.2	*Develop Software to Support CHART Performance Evaluation* – Collect and archive data related to the performance of the CHART program and analyze the data as an indicator of the program's effectiveness.	1
			5.16.3	*Further Develop Software to Predict Roadway Conditions During Adverse Weather Situations* – Software module deployment to improve the collection and processing of historical and real-time data from weather station field devices and thermal mapping applications in order to predict unsafe conditions along roadways.	1
			5.16.4	*Develop Map-based Graphical User Interface* (GUI) – Software module deployment to develop a customized map-based GUI for the CHART Operating System software to provide CHART personnel with accurate real-time geographical information to efficiently operate various CHART functions.	1
			5.16.5	*Develop Geographical Information System (GIS) Database for MDSHA Equipment Location* – Collect and develop GIS data for various permanent equipment locations (e.g., field devices, vehicle depots, cabinets, controllers, communications) to facilitate various operations through the use of a customized map-based GUI.	1
			5.16.6	*Develop CHART Portable Resource Tracking* – Software module deployment to facilitate CHART operations personnel's ability to track MDSHA and other agencies' portable field equipment (including device trailers, tow trucks, incident management equipment, and FITM trailers) in order to dynamically update exact locations and current usage status of available field equipment to be allocated when responding to incidents/emergencies.	1
			5.16.7	*Develop CHART Operator Decision Support* – Software module deployment to facilitate operational decision-making by providing several procedural options to a CHART staff responder that are based on predefined criteria, in order to better optimize incident/emergency and traffic management operations.	1

Objective		Element	Strategy		Priority
16	Develop additional capabilities within the CHART Operating System Software.	5 – SIC	5.16.8	*Develop Workstation Alert Subsystem* – Software module deployment to manage the distribution and display of alert messages (e.g., alerts from adverse weather detection devices) on workstations throughout the CHART network in order to assure that various types of alert messages are acknowledged, and by the appropriate personnel at the appropriate location.	1
			5.16.9	*Enhance Pager/Email/Fax/Cell Notification* – Update the existing software module to process notification messages for various operations and distribute them to the appropriate operational personnel or facility locations through the use of various predefined communication mediums.	1
			5.16.10	*Develop Web Browser-based CHART Interface* – Update the existing software module that provides a Web browser-based interface to the CHART system to allow flexible and widespread access to CHART Operating System functionality.	1
			5.16.11	*Integrate Traffic Probe Data*– Software module deployment to integrate into the CHART Operating System software traffic probe data collected through use of various technologies in order to determine traffic flow conditions along freeways and expressways and improve various CHART operations.	1
			5.16.12	*Exchange and Integrate Commercial Vehicle Operations (CVO) Data* – Provide, collect, and integrate data from and into commercial vehicle systems managed by state agencies and commercial operators in order to facilitate CHART's support of commercial vehicle operations along freeways and expressways.	1
			5.16.13	*Develop Access to Available HAZMAT Databases* – Initiate Maryland agency connectivity with national and state-level databases that provide information on HAZMAT carrier organizations and particular vehicles in order to better respond to incidents and emergencies involving hazardous materials.	1
			5.16.14	*Software for CHART System Health Monitoring* – Software module deployment to detect, locate, and track all failures, security breaches, and malfunctions within the CHART Operating System, communications network, or field devices.	1
			5.16.15	*Enhance Emergency Operations Reporting System (EORS)* - Continue to develop and improve the capabilities of the EORS network to improve incident/emergency operations throughout the state by overlaying data to and from CHART as well as Maryland Emergency Management Agency (MEMA) systems.	1
			5.16.16	*Develop Software for Control of Portable Devices* – Software module deployment to provide CHART personnel the ability to control portable field devices through the CHART Operating System.	1

Objective		Element	Strategy		Priority
17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	1 – TRM	1.17.1	*Expand SOC Video Distribution* – Purchase and install the necessary equipment to upgrade CHART's ability to internally distribute video images from the SOC.	1
		5 – SIC	5.17.1	*CHART Communications Network Build Out and Upgrade* – Purchase and install new, and replace and upgrade the technology of existing, switches, multiplexors, routers, hubs, codecs, cabling, modems, and servers to support the continued expansion of the CHART communications network.	1
			5.17.2	*Expand Communications to Local Agencies* – Extend communications to provide CHART data transfer capabilities with local jurisdiction agencies within Maryland.	1
			5.17.3	*SOC Integration and Equipment* – Plan, design, replace and upgrade equipment necessary to support the integration and inter-connectivity of CHART subsystems at the SOC.	1
			5.17.4	*Expand Communications to Adjacent States* – Extend communications with the necessary bandwidths to provide CHART data transfer capabilities with agencies' systems outside of Maryland.	1
			5.17.5	*Integrate Field Equipment Installations* – Deploy necessary communications, system components, and software updates to provide CHART data transfer capabilities with newly installed field devices and previously non-integrated legacy systems.	1
			5.17.6	*Deploy Secure Communications Between CHART Operations Centers and Emergency Management Systems* – Deploy secure and redundant communications to allow data transfer between CHART operations centers and various state, local, and federal emergency management agencies' systems to facilitate coordinated emergency management operations.	1
			5.17.7	*Increase CHART Network User Connections* – Deploy necessary hardware, software, and communications to provide transportation-related, public safety, and other appropriate agencies throughout the state access to the CHART system.	1
			5.17.8	*Wireless Communication Infrastructure* – Deploy necessary infrastructure to provide wireless communications with various field devices and other applications, including portable trailer-mounted devices, and permanent devices that present impractical circumstances for deploying wireline communications.	1
			5.17.9	*Satellite Communications Infrastructure* – Deploy necessary infrastructure to provide satellite communications for various CHART operations, primarily as a redundant source of communications for identified critical operations.	1

3.2 Projects Grouped by Objective

Table 13 presents the CHART NCDP Project names, and includes cost estimates for each Project. The full Project descriptions can be found in Appendix D – Project Definitions. This particular table groups the Projects by Objective, which is intended to provide the reader a specific practicable understanding of what CHART needs to build, develop, integrate, and initiate in order to achieve the operational capability defined in the associated Objective.

Therefore, grouping the Projects by Objectives will associate the Projects with a more specific purpose for carrying out the ITS deployment CHART will build – as opposed to grouping them by Element, which is at a less specific level. Appendix C – Projects Grouped by Element will thereby provide the reader the associated Projects to build the operational potential within each of the six CHART Elements.

Table 13 – CHART Project Names and Capital Cost Estimates, Grouped by Objective

Objective		Element	Project		Cost ($)
1	Enhance CHART's ability to visually monitor highway conditions.	1 - TRM	1.1.1.1	Deploy Additional CCTV Sites Along Freeways and Expressways	6,750,000
			1.1.1.2	Deploy Additional CCTV Sites Along Arterials	83,500,000
			1.1.1.3	Deploy Additional CCTV Cameras Along Freeway Incident Traffic Management (FITM) Routes	11,250,000
			1.1.2.1	Upgrade Existing CCTV Sites to NTCIP	178,500
			1.1.3.1	Deploy Video Detection Devices with CCTV Capability at Signalized Intersections	1,000,000
			1.1.4.1	Deploy Incident Monitoring Cameras on CHART Emergency Response Vehicles (This Project is repeated under Objective 6 as Project 2.6.5.1 - Costs reported here).	1,620,000
		5 - SIC	5.1.1.1	Develop Software for Collecting and Processing Video Detection Data	850,000
			5.1.1.2	Integrate "Machine Vision" Technology into CHART	1,600,000
			5.1.2.1	Integrate Aerial Video Systems into CHART	120,000
Objective 1 Total Capital Cost Estimate					$55,693,500
2	Enhance CHART's ability to collect automated traffic data from traffic detection sites.	1 - TRM	1.2.1.1	Deploy Additional Traffic Detectors	24,600,000
			1.2.1.2	Deploy Additional Traffic Detectors Along Freeway Incident Traffic Management (FITM) Route	5,320,000
Objective 2 Total Capital Cost Estimate					29,920,000

Objective		Element	Project		Cost ($)
3	Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data and reduced infrastructure requirements.	1 - TRM	1.3.1.1	Purchase Portable Trailer-Mounted Traffic Monitoring Cameras (This Project is repeated under Objective 1 as Project 1.13.2.1 - Costs reported here)	600,000
			1.3.2.1	Purchase Portable Trailer-Mounted Traffic Detectors (This Project is repeated under Objective 1 as Project 1.13.3.1 - Costs reported here)	450,000
			1.3.3.1	Deploy Cellular Telephone Geo-Location Traffic Data Collection Infrastructure	155,000
			1.3.4.1	Deploy Toll Tag Traffic Probe Devices Along Roadways	4,000,000
		5 - SIC	5.3.1.1	Integrate MDSHA Traffic Probe Data into CHART	250,000
			5.3.1.2	Integrate Traffic Probe Data from External Sources into CHART	470,000
Objective 3 Total Capital Cost Estimate					5,925,000
4	Enhance CHART's ability to monitor travel conditions during inclement weather.	6 – EWO	6.4.1.1	Deploy Additional Roadside Weather Stations	6,250,000
			6.4.2.1	Deploy MDSHA Snowplows with Road Surface Monitoring Technology	875,000
			6.4.3.1	Deploy Snowplows with Automatic Vehicle Location (AVL) Technology	9,000,000
Objective 4 Total Capital Cost Estimate					16,125,000

Objective		Element	Project		Cost ($)
5	Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	2 - IM	2.5.1.1	Purchase Incident Management Field Equipment for CHART Personnel	4,150,000
			2.5.2.1	Purchase Incident Management Field Equipment for Public Safety Agencies	980,000
			2.5.3.1	Provide Coordination and Resources for Training of Incident/Emergency Management Personnel	215,000
			2.5.4.1	Extend CHART Traffic Patrols	6,050,000
			2.5.5.1	Increase CHART Traffic Patrol in Existing Coverage Areas	340,000
			2.5.6.1	Deploy CHART Vehicle Depots	4,800,000
			2.5.7.1	Expand Coverage of CHART Traffic Operations Center (TOC) to all MDSHA Districts and Expand Existing Coverage	1,250,000
Objective 5 Total Capital Cost Estimate					18,655,000
6	Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	2 - IM	2.6.1.1	Deploy AVL Technology in Future CHART Vehicles	896,000
			2.6.3.1	Deploy Portable, Real-Time Data Acquisition Devices for Operational Personnel	150,000
			2.6.4.1	Deploy Wireless, Real-Time Data Sharing Devices for Operational Personnel	150,000
			2.6.5.1	Deploy Incident Monitoring Cameras on CHART Emergency Response Vehicles (This Project is repeated under Objective 1 as Project 1.1.4.1)	see 1.1.4.1
		5 - SIC	5.6.4.1	Deploy Geo-location Devices on Portable Incident/Emergency Management Equipment	300,000
Objective 6 Total Capital Cost Estimate					1,496,000

Objective		Element	Project		Cost ($)
7	Enhance CHART's severe weather and emergency management operations.	6 - EWO	6.7.1.1	Deploy CCTV Devices Along Evacuation Routes	4,000,000
			6.7.1.2	Deploy Traffic Detection Devices Along Evacuation Routes	3,150,000
			6.7.4.1	Deploy Traffic Management Infrastructure Along Evacuation Routes	7,800,000
			6.7.5.1	Deploy Satellite Voice Communications for Field Emergency Operations	159,000
Objective 7 Total Capital Cost Estimate					14,859,000
8	Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	3 - TI	3.8.1.1	Develop Enhancements for CHART Web Site	550,000
			3.8.4.1	Deploy Electronic Traveler Information Board System	22,580,000
			3.8.5.1	Deploy AM/FM Side-Band Traffic Alert Infrastructure	945,000
			3.8.6.1	Purchase Commercial Radio Station(s)	9,000,000
		5 - SIC	5.8.1.1	Integrate Traveler Information Data for Statewide 511 Distribution	705,000
			5.8.1.2	Deploy Updated Telephone Switching System and Message Storage and Playback System	1,500,000
Objective 8 Total Capital Cost Estimate					35,280,000

Objective		Element	Project		Cost ($)
9	Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	3 - TI	3.9.1.1	Deploy additional DMS Sites Along Freeways and Expressways	7,000,000
			3.9.1.2	Deploy Additional DMS Along Arterials at Freeway Interchanges	25,000,000
			3.9.2.1	Deploy Additional HAR Sites Along Freeways and Expressways	1,350,000
			3.9.2.2	Deploy Additional HAR Sites Along Arterials	1,350,000
			3.9.3.1	Deploy Replacement HAR at Existing Sites	500,000
			3.9.4.1	Deploy Replacement Portable Trailer-Mounted DMS (This Project is repeated under Objective 13 as Project 3.13.1.1 - Costs reported here)	1,120,000
			3.9.5.1	Deploy Replacement Portable Trailer-Mounted HAR (This Project is repeated under Objective 13 as Project 3.13.2.1 - Costs reported here)	150,000
			3.9.6.1	Deploy Roadside Infrastructure to Support In-Vehicle Highway Hazard Alert	640,000
			3.9.7.1	Deploy Roadside Infrastructure to Support In-vehicle Highway Signage Systems	565,000
Objective 9 Total Capital Cost Estimate					35,975,000
10	Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	5 - SIC	5.10.1.1	Integrate Traffic Signal Operation Systems into CHART	5,400,000
Objective 10 Total Capital Cost Estimate					5,400,000

Objective		Element	Project		Cost ($)
11	Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	4 - TM	4.11.5.1	Deploy Trail Blaze Signage for FITM Routes	1,200,000
			4.11.6.1	Deploy Highway Access Alert Systems	4,600,000
Objective 11 Total Capital Cost Estimate					5,800,000
12	Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	5 - SIC	5.12.1.1	Integrate Parking Management Systems	160,000
Objective 12 Total Capital Cost Estimate					160,000
13	Enhance ability to manage traffic and increase safety near and within work zones and event locations.	1 - TRM	1.13.1.1	Deploy Permanent Traffic Monitoring Equipment at Work Zones	1,700,000
			1.13.2.1	Purchase Portable Trailer-Mounted Traffic Monitoring Cameras (This Project is repeated under Objective 3 as Project 1.3.1.1)	see 1.3.1.1
			1.13.3.1	Purchase Portable Trailer-Mounted Traffic Detectors (This Project is repeated under Objective 3 as Project 1.3.2.1)	see 1.3.2.1
		3 - TI	3.13.1.1	Deploy Replacement Portable Trailer-Mounted DMS (This Project is repeated under Objective 9 as Project 3.9.4.1)	see 3.9.4.1
			3.13.2.1	Deploy Replacement Portable Trailer-Mounted HAR (This Project is repeated under Objective 9 as Project 3.9.5.1)	see 3.9.5.1
		5 - SIC	5.13.1.1	Deploy Geo-location Devices on Portable Work Zone/Event Equipment	500,000
			5.13.2.1	Integrate Geo-location Technology into CHART	45,000
Objective 13 Total Capital Cost Estimate					2,245,000

Objective		Element	Project		Cost ($)
14	Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	5 - SIC	5.14.1.1	Deploy Security Improvement Measures at CHART Operations Center	756,000
		6 - EWO	6.14.1.1	Deploy Security Monitoring Equipment at Field Device Locations	3,000,000
			6.14.2.1	Deploy Security Monitoring Equipment at Critical Infrastructure Locations	2,600,000
Objective 14 Total Capital Cost Estimate					6,356,000
Objective 15 Total Capital Cost Estimate					*
16	Develop additional capabilities within the CHART Operating System Software.	1 - TRM	1.16.1.1	CHART Virtual NTCIP Video Switch Interface	575,000
			1.16.1.2	Integrate CCTV with CHART connected agencies	444,000
			1.16.1.3	Integrate CCTV display with agencies not connected to CHART	190,000
			1.16.1.4	Support Display of Video to the Desktop at CHART Centers	500,000
			1.16.2.1	CHART Regional Traveler Information Clearinghouse Data Exchange	800,000
			1.16.3.1	Develop Standards-based CCTV Display and Control Software	550,000
			1.16.3.2	Develop Traffic Flow Monitoring Software	700,000
			1.16.3.3	Develop Aerial Video Display Software	450,000
			1.16.3.4	Develop Incident Management Monitoring Software	1,200,000
			1.16.3.5	Develop Weather and Road Condition Monitoring Software	1,000,000

Objective		Element	Project		Cost ($)
16	Develop additional capabilities within the CHART Operating System Software.	1 - TRM	1.16.3.6	Support Exchange and Integration of Work Zone/Evacuation Route Monitoring Software	860,000
			1.16.3.7	Develop Security Monitoring Software	475,000
		2 – IM	2.16.1.1	Integrate Incident/Emergency Call Center and OnStar Incident Detection Notification Systems	140,000
			2.16.2.1	Develop AVL-Equipped Resource Tracking Software	1,350,000
			2.16.2.2	Develop Incident/Emergency Field Response Text/Data Communication Software	925,000
			2.16.2.3	Develop Multi-jurisdictional CAD Operations Software	600,000
			2.16.2.4	Develop Multi-Jurisdictional Emergency Response Transportation Coordination Software	1,500,000
			2.16.3.1	CHART Incident Prediction Report Generation	1,100,000
			2.16.4.1	CHART Incident/Emergency Response Plan Generation	825,000
			2.16.5.1	Integrate Location Data from Wireless Enhanced 911 & #77 Information	460,000
			2.16.6.1	CHART Travel Condition Portal	560,000
			2.16.7.1	Develop Software for Multi-Modal Incident/Emergency Data Exchange	470,000
			2.16.8.1	Develop Software for Incident/Emergency Data Exchange for Highway Rail Crossings	397,000
			2.16.9.1	Develop Software for Incident Monitoring Cameras on Emergency Response Vehicles	300,000

Objective		Element	Project		Cost ($)
16	Develop additional capabilities within the CHART Operating System Software.	3 - TI	3.16.1.1	CHART Archive	525,000
			3.16.2.1	Multi-Modal Traveler Information Web Services	437,000
			3.16.3.1	Develop Software to Exchange/Integrate Data with/from Private ISPs	454,000
			3.16.4.1	Develop Software from Traveler Information Data Exchange	400,000
			3.16.4.2	Integrate Traveler Information Data Exchange with MDOT Business Units	15,000
			3.16.4.3	Integrate Traveler Information Data Exchange with Local Agencies	50,000
			3.16.4.4	Integrate Traveler Information Data Exchange with Adjacent States	10,000
			3.16.4.5	Develop Software to Integrate Parking Management Data	530,000
			3.16.5.1	Develop Electronic Traveler Information Board Software	660,000
			3.16.5.2	Develop AM/FM Side-band Traffic Alert Traveler Information Software	540,000
			3.16.5.3	Develop Commercial Radio Station Traveler Information Software	800,000
			3.16.5.4	Develop Software for Field Device Traveler Information	800,000
			3.16.5.5	Develop 511 Traveler Information Software	1,500,000
			3.16.5.6	Develop Software for In-vehicle Traveler Information	900,000

16	Develop additional capabilities within the CHART Operating System Software.	4 - TM	4.16.1.1	Integrate Data Related to Traffic Management Operations Along Arterials	675,000
			4.16.2.1	Develop Software to Incorporate Arterial Traffic Monitoring and Management into Freeway Operations	1,200,000
			4.16.3.1	Develop Software to Control Traffic Management Devices for Emergency Response/Evacuation Operations	800,000
			4.16.3.2	Develop Software for Operation of Ramp Metering Devices	650,000
			4.16.3.3	Develop Software for Operation of Variable Speed Limit Devices	750,000
			4.16.3.4	Develop Software for Operation of Lane Control Devices	740,000
			4.16.3.5	Develop Software for Operation of Queue Detection and Warning Devices	750,000
			4.16.3.6	Develop Software for Operation of Highway Access Alert Systems	780,000
			4.16.3.7	Develop Software for Operation of Dynamic Tolling Systems	720,000
			4.16.3.8	Develop Software for Operation of Traffic Management Devices at Inter-modal Transfer Points	700,000
			4.16.3.9	Develop Software for In-Vehicle Highway Hazard Alerts	800,000
			4.16.3.10	Develop Software for In-Vehicle Highway Signage Systems	850,000
			4.16.3.11	Develop Software for Advanced Technology Traffic Detectors	850,000

16	Develop additional capabilities within the CHART Operating System Software.	5 - SIC	5.16.1.1	CHART Real-Time Simulation	1,350,000
			5.16.1.2	CHART Offline Simulation	400,000
			5.16.1.3	CHART Training Simulation	350,000
			5.16.2.1	CHART Reporting	500,000
			5.16.3.1	CHART Weather Alert Processing	700,000
			5.16.4.1	CHART Map-Based Graphical User Interface	1,000,000
			5.16.5.1	CHART GIS Database Enhancement	450,000
			5.16.6.1	CHART Resource Tracking Support	500,000
			5.16.7.1	CHART Operator Decision Support	740,000
			5.16.8.1	CHART Alerts	300,000
			5.16.9.1	CHART Notification	800,000
			5.16.10.1	Develop Enhancements for CHART GUI	690,000
			5.16.11.1	CHART TSS Add Mobile Probe Data Device Type	347,000
			5.16.12.1	Integrate CVO Data	65,000
			5.16.12.2	Exchange CHART CVO data with other Agencies	525,000

16	Develop additional capabilities within the CHART Operating System Software.	5 - SIC	5.16.13.1	Integrate HAZMAT Data	64,000
			5.16.13.2	Develop Software to Interface with HAZMAT Data Sources	525,000
			5.16.14.1	Develop Software for Monitoring the Status of CHART	1,508,000
			5.16.15.1	Develop Software for EORS	400,000
			5.16.16.1	Develop Software to Support IP Wireless Communications	400,000
			5.16.16.2	Develop Software for Portable/Trailer-Mounted DMS	225,000
			5.16.16.3	Develop Software for Portable/Trailer-Mounted HARs	650,000
			5.16.16.4	Develop Software for Portable Data Collection Devices	750,000
Objective 16 Total Capital Cost Estimate					47,496,000
17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	1 - TRM	1.17.1.1	Integrate technology Refresh to Expand SOC Video Distribution	24,000
		5 - SIC	5.17.1.1	Deploy Additional CHART Fiber Connections	6,600,000
			5.17.2.1	Deploy Communications to Local Agencies and Jurisdictions	200,000
			5.17.2.2	Integrate Communications to Local Agencies and Jurisdictions	500,000
			5.17.3.1	Integrate SOC Subsystems	350,000
			5.17.4.1	Deploy Communications Infrastructure with Adjacent States	20,000

17	Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	5 - SIC	5.17.4.2	Integrate Communications Infrastructure with Adjacent States	90,000
			5.17.5.1	Integrate New Field Equipment Locations	8,500,000
			5.17.5.2	Integrate Radio Station(s) into CHART Operations	26,000
			5.17.6.1	Integrate Secure Communications to CHART Sites	240,000
			5.17.6.2	Emergency Backup Voice Communications between TOCs and Regional EOCs	51,500
			5.17.7.1	Deploy CHART Network Equipment at Public Safety and Transportation-related Agencies	250,000
			5.17.7.2	Integrate CHART Network Connections at Public Safety and Transportation Related Agencies	625,000
			5.17.8.1	Integrate Wireless Device Communications	647,000
			5.17.9.1	Deploy Satellite Communications for Redundant Communication Links	120,000
			5.17.9.2	Integrate Redundant Satellite Communications Links	320,000
Objective 17 Total Capital Cost Estimate					18,563,500
NCDP TOTAL CAPITAL COST ESTIMATE					299,949,000

* Objective 15 does not have a capital cost estimate because it only consists of Strategies in which CHART is acting in a supporting role to another agency initiative (see Section 2.4.3). In these supporting roles, CHART may incur little or no capital costs.

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4. Benefits of CHART

4.1 Role of CHART in Combating Traffic Congestion

Cost of Traffic Congestion

The 2007 version of the Annual Urban Mobility Report – a widely acknowledged study by the Texas Transportation Institute (TTI) – released statistics measured in 2005 that indicate an average yearly cost of $710 per traveler (in 2005 dollars) due to congestion totaling a cost of $78 billion in extra time and fuel for the 437 urban U.S. cities studied. Congestion also caused an annual delay of 38 hours and 26 gallons of wasted fuel per peak-hour traveler. Average yearly costs in the Baltimore and Washington, D.C. urban areas were estimated at $881 and $1,094 per traveler, respectively.

Nature of Congestion

There are considered to be two types of congestion: Recurring and non-recurring. Recurring congestion occurs when the number of vehicles traveling on the highways exceeds the capacity those roads were designed to efficiently carry, leading to reduced speeds, and congestion. This type of congestion is referred to as recurring because it tends to occur day-after-day, often at the same times and in the same locations. Non-recurring congestion occurs due to factors such as automobile crashes, breakdowns, construction, special events, and weather conditions. Table 14 below highlights some of the differences between the two types of congestion. In the Baltimore and Washington, D.C. urban areas, TTI estimates that 55% and 50%, respectively, of total delay is due to non-recurring conditions.

Potential Solutions to Congestion

The TTI report states that, in considering estimated growth levels in the 437 urban areas studied, current spending for new road construction needs to be at least doubled in order to prevent a worsening in today's congestion levels. In general, new construction is viewed as an appropriate response to recurring congestion. However, as TTI points out, because raising highway construction budgets to these levels is unlikely, adding travel capacity through new construction can only serve as part of the total solution to solving congestion. Moreover, new construction does not address non-recurring congestion, which is approximately half of the congestion problem. The other part of the perceived solution, which addresses non-recurring congestion, is known as transportation system management and operations. Table 14 provides an overview of the two types of

congestion, some of their causes, as well as the two different types of strategies to mitigate those causes.

Table 14 - Types of Congestion with Usual Mitigation Strategy

Type of Congestion	Representative Causes of Delay	Mitigation Strategy
Recurring	Infrastructure capacity shortfalls	Capacity increases
	Interchange bottlenecks	
	Weave and merge friction	
	Non-optimized traffic signal timing*	Systems operations and management
Non-recurring	Breakdowns and crashes	
	Construction work	
	Weather	
	Vehicle mix	

* Note that while non-optimized signal timing will lead to recurring congestion, it is addressed through better operations and management, not new capacity.

Transportation System Operations and Management

In the past, highways were built and then there was comparatively little emphasis on effectively operating and managing day-to-day traffic on the highway system. As resources for new construction have become scarcer, and as highways have become more congested, attention has been focused on strategies to more effectively move traffic on a day-to-day basis. Some standard operations and management strategies include:

- Adding monitoring capabilities to highways, as well as enhanced traffic detection, so unusual levels of congestion can be quickly determined and addressed
- Improving techniques and coordination for the clearance of vehicles involved in incidents
- Disseminating timely information to travelers so they can make informed travel decisions resulting in a more efficient use of the roadways
- Maximizing the use of road lanes through deployments such as reversible and high occupancy vehicle (HOV) or managed toll lanes
- Installing vehicle location systems on highway agency and contractor vehicles to better track use of operating resources
- Stabilizing the flow of vehicles onto expressways through ramp metering
- Better optimizing traffic signal timing plans to provide optimal traffic flows

Applying a range of such strategies as above will collectively decrease levels of congestion and delay, increasing the reliability of how long/much it will take for Maryland travelers to arrive at their destinations.

Supporting transportation management and operations solutions also takes significant steps toward addressing safety. High congestion levels result in more closely spaced vehicles on a roadway, which provides more opportunities for conflict. Another aspect of unsafe travel is secondary crashes – crashes that occur due to conditions produced by an existing crash. Detecting, managing, and clearing accidents from the roadway as efficiently as possible will directly decrease the likelihood of secondary crashes. Also, applications in technology can detect probable weather-related hazards, and better manage the resources to mitigate them.

In Maryland, the CHART program is MDSHA's primary contributor toward enhanced system management and operations. In essence, the CHART program was established to tackle approximately half of the congestion problem that is non-recurring. Other MDSHA programs also contribute, e.g., the Office of Traffic and Safety (OOTS) for traffic signal optimization program. Additional representative agencies that contribute include the Maryland State Police, especially for incident clearance, and transit agencies to the extent they are able to provide service that reduces highway congestion. As noted below, the CHART program – sometimes in conjunction with other programs and agencies – has made a beneficial difference, especially in the incident management arena.

Resource Imbalance Between Congestion Solutions in Maryland

As noted in the Nature of Congestion section above, Maryland's CHART program addresses roughly 50% of the delay and lack of system reliability not addressed by the Administration's capital improvements program, and does so in a highly effective manner.

The Consolidated Transportation Plan (CTP) allocation for CHART for fiscal years 2008-2013 shows expenditures of $12.8 million in capital costs and $8.44 million in operations and maintenance costs in 2008. At the current level, funding for the CHART program will be approximately $127 million over the next six years. In comparison, funding for MDSHA capital costs is budgeted at $5.6 billion for the same six-year period in the 2008-2013 MDOT CTP. Furthermore, Maryland's new highway infrastructure construction needs are estimated at $51.4 billion in the MDSHA Highway Needs Inventory – a high-level estimate based on serving existing and projected population and economic activity.

CHART is not the only program involved in management and operations of the state highway system, but it is a large part. Therefore, as may be seen, the proportionate share of funding devoted to transportation systems operations and management tends to be relatively small compared to new construction. Given the difficulty in keeping pace with congestion through new construction, focusing additional attention on the operations and management part of the congestion solution through increased funding could pay large dividends.

4.2 CHART Cost-benefit Evaluation

CHART Benefits in Brief

While described in greater detail below, the CHART program's focus on non-recurring congestion in the year 2007 has:

- Reduced incident durations by 41 percent (average from 2000 to 2007)
- Returned $1.118 billion in savings from fewer delayed vehicle hours to Maryland travelers
- Lowered emissions levels

Initial CHART Evaluation

The first CHART program evaluation encompassed data collected from FY 1990 to FY1994. This initial evaluation demonstrated that the benefits of CHART operations, supported by a small (at that time) core of traffic and roadway monitoring devices, exceeded the system's capital, operating, and maintenance costs by a ratio of over 7 to 1. This evaluation compared the estimated reduction in delay, fuel consumption, and secondary incidents (benefits) to the capital, operating, and systems maintenance costs of the program.

The evaluation was performed at three levels: System-wide, corridor-level, and site-specific, and comparisons were made between the findings and conclusions from each level of evaluation. The findings also concluded that CHART incident management patrols were being used where they were needed most. That is, they were covering the segments of the network that experience the highest number of incidents per mile, resulting in the most non-recurring delay and congestion.

More Recent CHART Evaluations

Since 1999, the Civil Engineering Department of the University of Maryland at College Park has developed a yearly assessment of the effectiveness of CHART with an emphasis on the program's ability to detect and respond to incidents on major freeways and highways (Note: A pilot study was also conducted in 1997 that

underpins the later work). These newer evaluation studies benefit from a significant increase in collected data and accuracy due to the implementation of the CHART II Database.

The most updated program evaluation at time of this report (released May 2008) provides statistics and a cost savings analysis for CHART operations carried out in the year 2007, and then compares those figures to previous year analyses. Table 15 shows the number of motorist assists and incident responses where data was collected to support the Year 2007 evaluation report.

Table 15 – University of Maryland Study – CHART Motorist Assists and Incident Response Statistics from 1999 to 2007

Calendar Year	Total Assists to Motorists	Total Responses to Incidents	Total
1999	22,987	5,000	27,987
2000	26,204	8,687	34,891
2001	16,695	9,313	26,008
2002	19,062	13,752	32,814
2003	20,455	18,068	38,523
2004	21,412	19,127	40,539
2005	20,681	20,515	41,196
2006	22,988	21,055	44,043
2007	21,085	21,236	42,321

Due to a lack of reliable incident response data prior to the deployment of CHART/MDSHA response units, a typical before-and-after analysis is not feasible. Therefore, the alternative was to compute the average incident clearance time in Year 2007 with and without the assistance from CHART.

Without CHART/MDSHA response units, the average incident duration was approximately 27 minutes, while the average incident duration with CHART was approximately 21 minutes – about a thirty-two percent (22%) reduction in the average incident duration (see Table 16 below). Of special note, the University of Maryland's statistics show that incident average durations are not only decreasing for incident responses where CHART Patrol vehicles are involved, but also for

those where only other agencies (e.g., state police and local public safety) responded. This trend suggests that efficient response to incidents has received increasing attention among all responsible agencies.

Table 16 – University of Maryland Study – CHART Incident Average Duration from 1997 to 2007

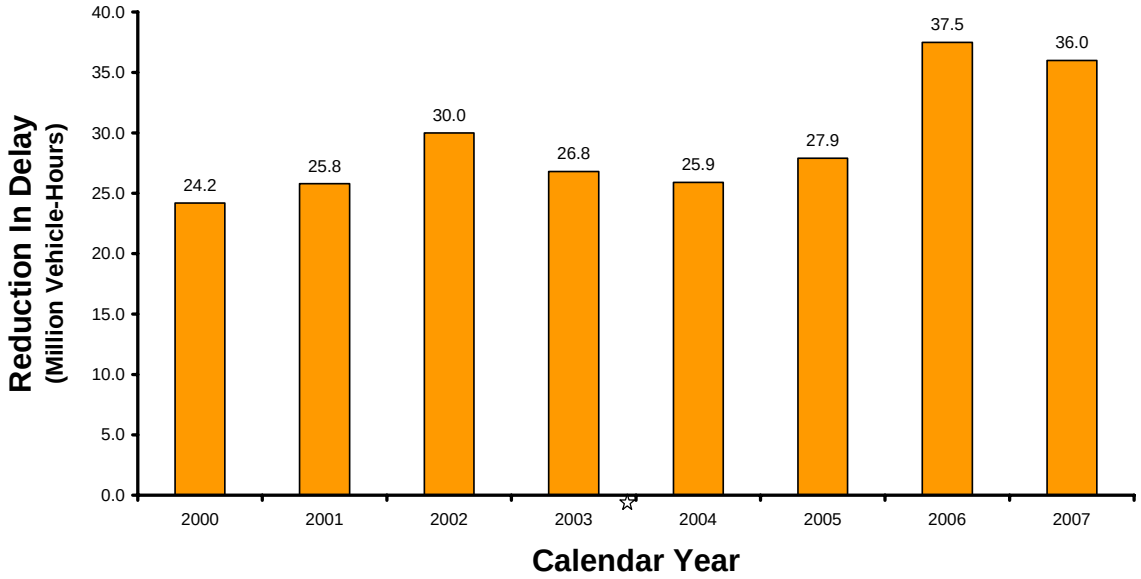
Year	CHART Incident Average Duration
1997*	45 minutes (68 min. without CHART)
1999	42 minutes (93 min. without CHART)
2000	33 minutes (77 min. without CHART)
2001	29 minutes (51 min. without CHART)
2002	27.7 minutes (38.8 min. without CHART)
2003	39.5 minutes (49.1 min. without CHART)
2004	42.34 minutes (46.24 min. without CHART)
2005	22 minutes (29 minutes without CHART)
2006	23 minutes (32 minutes without CHART)
2007	21 minutes (27 minutes without CHART)
Average	32.5 minutes (51.1 minutes without CHART)

*** Pilot Study with Partial Data**

Notes: this data does not include "outlier" data from incidents with durations longer than 2 hours; analysis not performed for 1998.

It was also found that secondary incidents, defined as "the number of incidents occurring within two hours after a major incident and within a range of two miles," have been potentially reduced by 491 in 2007. Thus, the reduction in secondary incidents implies additional savings in travel time, fuel consumption and congestion. This is especially significant toward achieving safety benefits because secondary incidents commonly involve more serious injuries and fatalities than do initial incidents.

Overall, reduction in Year 2007 travel delay due to CHART operations was found to be 35.98 million vehicle hours, saving consumers 6.07 million gallons of fuel for that year.



***Changed the method of Reduction in Delay Calculation in 2003**

Figure 4 – Yearly Reduction in Delay Resulting form CHART Operations

Using the time value of $26.58/hour (the average hourly income in Maryland), $20.68/hour (truck driver's cost), $45.40/hour (cargo's cost) and the unit value of $2.86/gallon, the total trip cost savings due to delay reduction was estimated to be $1.06 billion in traveler time, and $17 million in fuel.

Similarly, reductions in vehicle emissions were estimated at 470.41 million tons for hydrocarbon (HC), 5,283.47 million tons for carbon monoxide (CO), and 225.29 million tons for nitric oxide (NO). Using the unit rates of $6,700/ton, $6,360/ton, and $12,875/ton respectively, the total savings in emissions due to CHART operations is estimated at $39.66 million. This brings the total savings for CHART operations in 2007 to $1.12 billion. Table 17 presents a summary of the Year 2007 findings for the evaluation of CHART incident management operations.

Table 17 – University of Maryland CHART 2007 Incident Management Evaluation Findings

Reduction due to CHART		Amount	Unit rate	In Dollars (million)
Delay (million veh-hrs)	Truck	2.661	$20.68/hour (truck driver's cost)	55.02
			$45.40/hour (cargo's cost)	120.79
	Car	33.323	$26.58/hour (car driver's cost)	885.72
Fuel consumption (million gallons)		6.074	$2.86/gal.	17.37
Emissions (tons)	HC	470.41	$6,700/ton	39.66
	CO	5,283.47	$6,360/ton	
	NO	225.29	$12,875/ton	
Total Savings				$ 1,118.55

Figure 5 presents a yearly cost-to-benefit comparison for CHART operations from 2000 to 2007. This comparison is based on the total user cost savings figures for the yearly University of Maryland evaluations compared with the actual CHART Program capital and operations costs. Using the most recent numbers available, the CHART Benefit-Cost Ratio for the year 2007 is as follows:

$$\frac{\textit{Total Savings/Benefit to Highway Users for 2007 (\$1,118.2 Million)}}{\textit{Total Capital and Operational Costs for 2007 (\$21.2 Million)}} = 52.74$$

As can be seen, the benefits of the CHART program far outweigh the allocated Capital and Operational costs.

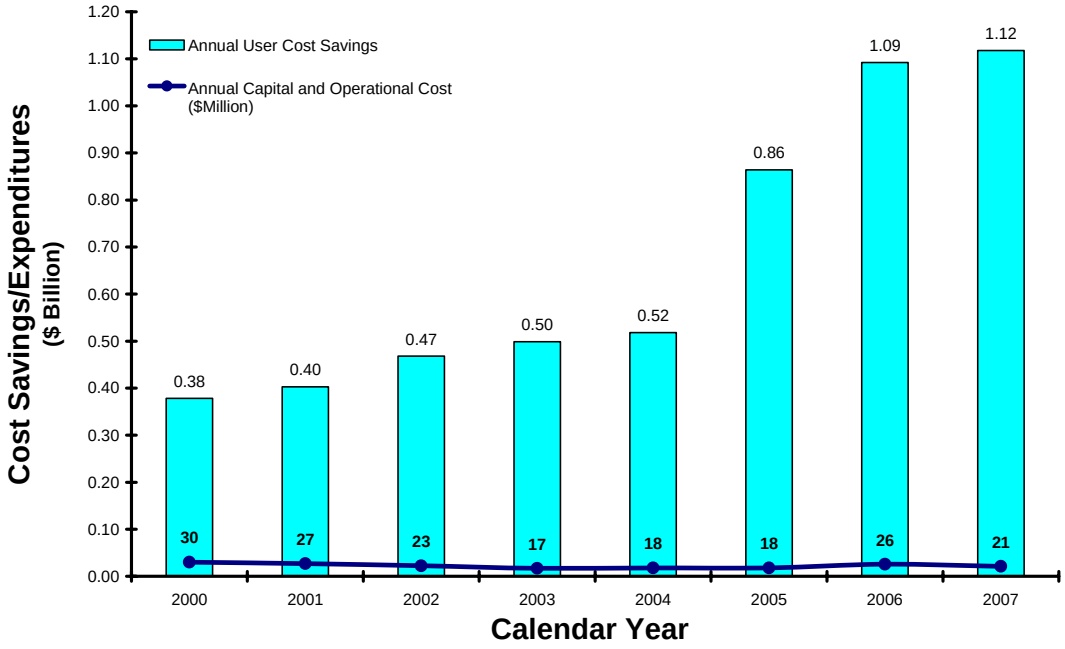


Figure 5 – Comparison of Annual User Cost Savings Found through University of Maryland CHART Evaluation Studies Conducted from 2000 to 2007 and CHART Program Operating Cost

4.3 Benefits from Implementing 2008 CHART NCDP

The following section provides examples of qualitative benefits that are currently being experienced by Maryland travelers due to CHART operations, as well as benefits (including economic benefits to the State of Maryland) that will be realized through the implementation of the deployments contained within the 2008 NCDP.

Current CHART qualitative benefits include:

- Access to various sorts of travel information via website and radio, including weather conditions, roadway surface conditions, traffic video images, variable message sign (VMS) postings, location-based traffic speeds, incident reports, lane closures, as well as road work durations and locations
- Decreased delay from non-recurring events (e.g., crashes, breakdowns, construction, weather) on state and other roadways
- Decreased fuel consumption and cleaner air due to fewer emissions
- Safer and quicker management of roadway incidents, and fewer secondary incidents
- Increased security safety along roadways, including during construction, adverse weather, and catastrophic events

In addition to more of the benefits in the above list, potential CHART qualitative benefits introduced by deployments within the 2008 NCDP are provided in Table 18 below. This table maps specific benefits provided by the NCDP for Maryland travelers.

Table 18 – Potential 2008 CHART NCDP Benefits Mapped to Overall Traveler Benefit

NCDP Benefit	Increased Traveler Benefit		
	Mobility	Reliability	Safety
More efficient, useful, and personalized traveler information	X	X	X
Improved and increased access to traveler information, including private sector dissemination of information from CHART	X	X	
Consolidated source(s) of traveler information for multi-modal travelers	X	X	
Increased operational management at inter-modal transfer points	X	X	
Increased emergency management and evacuation services			X
More secure and redundant transportation management services			X
Safer and quicker management of roadway incidents/emergencies requiring multi-jurisdictional response	X	X	X
Increased management of traffic flow on highways	X	X	
Increased management of tolled roadways	X	X	
Increased management of, and safety within, scheduled event and work zone locations	X	X	X
Increased safety at highway/rail crossings			X
Increased real-time services due to implementation of latest system technologies	X	X	X
Increased safety, mobility, and reliability due to coordinated management of commercial vehicles and hazardous material shipped along roadways.	X	X	X

Potential CHART qualitative economic benefits to Maryland introduced by deployments within the NCDP include:

- Increased tourism throughout Maryland due to better traveling conditions and dissemination of traveler/tourism information
- Increased mobility of employees/goods along Maryland highways benefiting Maryland workers and businesses
- Decreased cost of doing business for motor carriers due to more efficient cargo transport throughout Maryland
- Quicker highway system recovery from emergency situations leading to normal highway operating conditions
- Reduced fatalities and injuries along roadways leading to fewer medical costs for public
- Fewer air-pollution medical effects and thus fewer medical costs

A qualitative summary of Project benefits is included within the Project definitions (Appendix D – Project Definitions) in order to provide an outline of the user-based operational, economic cost-savings, and other benefits that are anticipated to be realized through the implementation of each Project. These anticipated benefits serve as a reference to decision-makers, CHART planning and deployment staff, as well as developers of future CHART business plans.

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CHART

NCDP

Appendicies A-E

Appendicies A-E

Appendix A – Acronyms List

AM	Amplitude Modulated
AOC	Authority Operations Center
API	Application Programming Interface
ASTM	American Society for Testing and Materials
ATIS	Advanced Traveler Information Systems
ATM	Asynchronous Transfer Mode
ATR	Automatic Traffic Recorder
AVCM	ATM Video Control Manager
AVL	Automatic Vehicle Location
BWI	Baltimore-Washington International
C2C	Center to Center
CA	Computer Associates
CAD	Computer Aided Dispatch
CCTV	Closed-Circuit Television
CHART	Coordinated Highways Action Response Team
CORBA	Common Object Request Broker Architecture
COTS	Commercial-Off-The-Shelf
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
DATEX-ASN	Data Exchange ASN.1
DEMA	Delaware Emergency Management Agency
DMK	Dynamic Management Kit
DMS	Dynamic Message Sign
DSRC	Dedicated Short-Range Communication
DVR	Digital Video Recording
EOC	Emergency Operations Center
EORS	Emergency Operations Reporting System
ETP	Emergency Traffic Patrols
ERU	Emergency Response Unit
FEMA	Federal Emergency Management Agency
FITM	Freeway Incident Traffic Management
FM	Frequency Modulated
GIS	Geographic Information System
GPS	Global Positioning System
GUI	Graphical User Interface
HAR	Highway Advisory Radio
HIB	Hazard Identification Beacon
HP	Hewlett-Packard
HTML	HyperText Markup Language
IEEE	Institute of Electrical and Electronics Engineers, Inc.

IP	Internet Protocol
IRIS	Intelligent Roadside Information System
ISDN	Integrated Services Digital Network
ITS	Intelligent Transportation System
J2ME	Java 2 Micro Edition
JAAS	Java Authentication and Authorization Service
JDBC	Java Database Connectivity
JMX	Java Management Extensions
JSP	JavaServer Pages
LATA	Local Access Transport Area
LED	Light Emitting Diode
MAA	Maryland Aviation Administration
MDOT	Maryland Department of Transportation
MdTA	Maryland Transportation Authority
MIDP	Mobile Information Device Profile
MMTIS	Multi-modal Traveler Information System
MS/ETMCC	Message Sets for External Traffic Management Center Communication
MD SHA	Maryland State Highway Administration
MTA	Maryland Transit Administration
MVA	Motor Vehicle Administration
NMS	Network Management System
NTCIP	National Transportation Communications for ITS Protocol
ODBC	Open Database Connectivity
OOTS	Office of Traffic and Safety
PEMA	Pennsylvania Emergency Management Agency
POTS	Plain Old Telephone System
PSTN	Public Switched Telephone Network
PTZ	Pan Tilt Zoom
RAID	Redundant Array of Inexpensive Disks
RF	Radio Frequency
RITIS	Regional Integrated Transportation Information System
RLCSS	Reversible Lane Control Signal System
RSVD	Roadside Vehicle Detection
RTMS	Remote Traffic Microwave Sensor
RWIS	Remote Weather Information System
SAE	Society of Automotive Engineers
SAN	Storage Area Network
SF	Square Feet
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol
SOC	Statewide Operations Center
SQL	Structured Query Language
TCP	Transmission Control Protocol
TMDD	Traffic Management Data Dictionary

TNG	The Next Generation
TOC	Traffic Operations Center
TSS	Traffic Sensor Subsystem
VDEM	Virginia Department of Emergency Management
VMS	Variable Message Sign
W3C	World Wide Web Consortium
WAN	Wide Area Network
WAP	Wireless Application Protocol
XML	Extensible Markup Language

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Appendix B – Strategies Grouped by Element

Element		Objective	Strategy		Priority
1	Traffic and Roadway Monitoring	1 - Enhance CHART's ability to visually monitor highway conditions.	1.1.1	*Additional Closed-Circuit Television (CCTV)* – Deploy CCTV cameras along major state highways in the Baltimore and Washington, D.C. regions to provide full visibility of roadways. Continue to extend CCTV camera coverage statewide to include all major state highways, as well as evacuation and Freeway Incident Traffic Management (FITM) routes.	*1*
			1.1.2	*Upgrade Existing Closed-Circuit Television (CCTV)* – Upgrade the technology of existing CCTV infrastructure to continue CHART's ability to effectively monitor roadway conditions by using the latest technological developments.	*2*
			1.1.3	*Traffic Monitoring at Video Detection Sites* – Deploy roadside infrastructure to enable CHART to access data and images from video detection cameras at signalized intersections.	*1*
			1.1.4	*Incident Monitoring Cameras on Emergency Response Vehicles* – Deploy camera image or video capture technology on CHART Emergency Response Vehicles to provide near real-time monitoring of field conditions (This Strategy is repeated under Objective 6 as Strategy 2.6.5).	*1*
		2 - Enhance CHART's ability to collect automated traffic data from traffic detection sites.	1.2.1	*Additional Roadside Traffic Detectors* – Deploy new detection sites along major state highways in the Baltimore/Washington, D.C. regions to provide full detection at 1-mile spacing of roadways. Continue to extend roadside traffic detection coverage statewide to include major state highways as well as designated evacuation and Freeway Incident Traffic Management (FITM) routes.	*1*
			1.2.2	*Support for Deployment of Vehicle Passenger Occupancy and Class Determination Detectors* – Support the deployment of detection devices along freeways and expressways with the capability to determine vehicle class types (car, truck type) and a vehicle's passenger occupancy (HOV) in order to provide data for various operations.	*S-3*

1	Traffic and Roadway Monitoring	3 - Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data and reduced infrastructure requirements.	1.3.1	*Portable Trailer-mounted Traffic Monitoring* Cameras – Obtain portable camera trailers with wireless communications in order to provide flexible monitoring capabilities at any location. (This Strategy is repeated under Objective 13 as Strategy 1.13.2.)	1
			1.3.2	*Portable Trailer-Mounted Traffic Detectors* - Obtain portable traffic detection trailers with wireless communications, as well as intrusion detection devices, in order to provide flexible safety monitoring, traffic data collection, and queue detection at any location. (This Strategy is repeated under Objective 13 as Strategy 1.13.3.)	1
			1.3.3	*Traffic Probe Data Collection* – deploy necessary infrastructure – either directly or through partnerships with public or private agencies – to support the collection of traffic probe data through use of various technologies in order to determine traffic flow conditions along freeways and expressways.	1
			1.3.4	*Toll Tags as Traffic Probes* – Deploy infrastructure to collect and process data from vehicle toll tags along state freeways and expressways in order to determine travel times and traffic flow conditions.	2
			1.3.5	*Support Deployment of Traffic Probe Devices in MDOT Vehicles* – Support other agencies in equipping vehicles owned by Maryland Department of Transportation Modals with technology applications that allow traffic flow data to be collected while traveling along roadways.	S-1
		12 - Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	1.12.1	*Support Partnerships to Monitor Parking Facilities* – Develop partnerships to monitor parking capacity and other operations at major public parking facilities as well as at recurring event locations, Park 'n' Ride locations, and airports.	S-2
		13 - Enhance ability to manage traffic and increase safety near and within work zones and event locations.	1.13.1	*Work Zone/Event Traffic Monitoring Infrastructure* – Where applicable, deploy permanent infrastructure to support traffic flow detection and video monitoring capabilities at work zones (for continued coverage after completion of construction) and major event locations.	1
			1.13.2	*Portable Trailer-mounted Traffic Monitoring Cameras* - Obtain portable camera trailers with wireless communications in order to provide flexible monitoring capabilities at work zones and event locations. (This Strategy is repeated under Objective 3 as Strategy 1.3.1.)	1
			1.13.3	*Portable Trailer-Mounted Traffic Detectors* - Obtain portable traffic detection trailers with wireless communications, as well as intrusion detection devices, in order to provide flexible safety monitoring, traffic data collection, and queue detection at work zones and event locations. (This Strategy is repeated under Objective 3 as Strategy 1.3.2.)	1

1	Traffic and Roadway Monitoring	15 - Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.	1.15.1	*Support for Highway-rail Crossing Monitoring Devices* – Support the deployment of devices that detect both automobiles and approaching trains at highway-rail crossings to support various safety alert systems, as well as traffic management systems.	S-2
		16 - Develop additional capabilities within the CHART Operating System Software.	1.16.1	*Exchange Closed-Circuit Television Images and Camera Control* – Software module deployment for collecting and integrating video images and camera control interfaces from sources outside of CHART, as well as providing CHART camera images and administered control to outside agencies.	1
			1.16.2	*Exchange and Integrate Traffic Monitoring Data with Other Agencies* – Software module deployment for processing traffic monitoring and detection data from CHART devices and sending it to other agencies, as well as receiving and integrating traffic monitoring data from outside sources and integrating it into the CHART Operating System.	1
			1.16.3	*Develop Traffic and Roadway Monitoring Software* – Software module deployment to provide added functionality to traffic and roadway monitoring operations within CHART software.	1
		17 - Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	1.17.1	*Expand SOC Video Distribution* – Purchase and install the necessary equipment to upgrade CHART's ability to internally distribute video images from the SOC.	1

Element		Objective	Strategy		Priority
2	Incident Management	5 - Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	2.5.1	*CHART Incident Management Field Equipment* – Continue to purchase the most advanced field equipment (including vehicles, clearance machinery, etc.) to enhance CHART incident management personnel's ability to detect, respond, and clear incidents and emergencies along state highways in all jurisdictions.	*1*
			2.5.2	*Public Safety Incident Management Equipment* – Provide and transfer equipment to Maryland State Police and other public safety agencies to improve coordination and joint activities with CHART.	*1*
			2.5.3	*Incident/Emergency Management Training* – Train personnel, both within the CHART program and from other agencies, to familiarize operational and technical staff with the underlying principals of incident/emergency management, ITS applications, and the impacts of congested roadways.	*1*
			2.5.4	*Extend CHART Traffic Patrol* – Extend CHART traffic patrol program to include coverage in every MDSHA Engineering District.	*1*
			2.5.5	*Increase Existing CHART Traffic Patrol Coverage* – Expand the CHART traffic patrol program to increase existing coverage in the Baltimore and Washington, D.C. regions to 24x7 coverage.	*1*
			2.5.6	*CHART Vehicle Depots* – Build CHART vehicle depots in the Baltimore and Washington, D.C. areas to facilitate vehicle management and maintenance.	*1*
			2.5.7	*CHART Traffic Operations Center (TOC) Expansion* – Extend CHART operational coverage to include deployment of a TOC in every MDSHA Engineering District.	*1*
		6 - Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	2.6.1	*Automated Vehicle Location (AVL)* on *MDSHA Incident/Emergency Vehicles* – Deploy Global Positioning System (GPS)-based AVL devices and systems to collect MDSHA incident/emergency vehicle location data, in order to more efficiently manage MDSHA field resources during incidents and emergencies.	*1*
			2.6.2	*Support for Opening Local Operations Centers* – Support counties and municipalities in their efforts to establish regional ITS programs and operations centers with functions that will be integrated inter-regionally with the CHART SOC.	*S-1*
			2.6.3	*Real-time Data Acquisition Devices* – Equip operational personnel with portable devices that will be used to gather real-time information on CHART field operations.	*1*
			2.6.4	*Wireless Real-time Data Sharing Devices* – Equip remote incident management personnel with portable devices to support the exchange of messages and information to facilitate incident/emergency management field operations.	*1*
			2.6.5	*Incident Monitoring Cameras on CHART Emergency Response Vehicles* – Deploy camera image or video capture technology on CHART Emergency Response Vehicles to provide near real-time monitoring of field conditions (This Strategy is repeated under Objective 1 as Strategy 1.1.4).	*1*

Element		Objective	Strategy		Priority
2	Incident Management	16 - Develop additional capabilities within the CHART Operating System Software.	2.16.1	*Integrate Emergency Notification Data from MAYDAY Systems* – Software module deployment to collect and integrate MAYDAY notification data from outside systems into the CHART Operating System to facilitate incident/emergency management operations that accurately locate and verify incidents and emergencies through a common map interface.	2
			2.16.2	*Develop Incident/Emergency Management and Computer Aided Dispatch (CAD) Software* – Software module deployment to develop the CHART system software to process operations data from multi-jurisdictional public safety and transportation-related agencies responsible for incident/emergency detection, verification, response, and clearance in order to optimize MDSHA incident/emergency management and dispatch operations throughout the state.	1
			2.16.3	*Develop Incident Prediction Software* – Software module deployment that uses various sources of data as input into an algorithm that processes predictions and probabilities for incidents occurring along stretches of highways where data is being collected.	2
			2.16.4	*Develop Incident/Emergency Notification Software* – Software module deployment that generates an automated response by notifying the most appropriate agencies based on processed data defining the incident/emergency parameters, as well as processed data on real-time status of resources available to respond to the incident/emergency.	1
			2.16.5	*Integrate Incident Location Data from Wireless Enhanced 911 and #77 Systems* – Software module deployment to collect and integrate geo-location data from 911 and #77 callers into CHART software applications in order to accurately locate and verify incidents/emergencies through a common map interface.	1
			2.16.6	*Provide Travel Condition Data to Public Safety and Transportation Agencies* – Software module deployment that generates an automated response by processing requests from agencies responding to a particular incident/emergency in order to provide real-time travel conditions for the given travel route.	1
			2.16.7	*Multi-modal Incident/Emergency Information Clearinghouse* – Software module deployment to collect and integrate incident/emergency data from multi-modal agencies into the CHART Operating System, as well as to process requests for multi-modal incident/emergency data and distribute it to various sources in a standard format.	1
			2.16.8	*Integrate Incident/Emergency Rail System Data* – Software module deployment to collect and integrate incident/emergency data from various Rail Carrier Systems into the CHART Operating System in order to improve incident detection and traffic management at and around highway-rail crossings.	2
			2.16.9	*Integrate Incident Monitoring Cameras on CHART Emergency Response Vehicles* – Software module/enhancement to support the integration and distribution of this video through the CHART Operating System.	1

Element		Objective	Strategy		Priority
3	Traveler Information	8 - Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	3.8.1	*CHART Web Site Enhancements/Development* – Enhance the functionality and traveler information services provided to the public through "CHART on the Web".	1
			3.8.2	*Support Regional Advanced Traveler Information Programs* –Support regional programs that manage various sources of transportation data in order to provide a "one-stop shopping" source for the public to access multi-modal traveler information through various media.	S-1
			3.8.3	*Support Information Service Provider Partnerships* – Support for partnerships with ISPs, which manage and/or fuse transportation data, and distribute traveler information through various dissemination media.	S-1
			3.8.4	*Electronic Traveler Information Board* – Install display units to provide real-time traffic and transportation information at various locations. Such as rest areas, airports, Motor Vehicle Administration (MVA) facilities, and transit transfer points.	2
			3.8.5	*AM/FM Side-Band Traffic Alerts* – Deploy necessary infrastructure to provide CHART the ability to broadcast traveler information over AM/FM frequencies using technology that transmits data to vehicles equipped with receivers.	3
			3.8.6	*Commercial Radio Station(s) to Broadcast Regional Travel Information* – Purchase commercial radio stations within various regions in order to provide travelers with a dedicated, high-quality, and reliable source for up-to-date regional traveler information.	1
		9 - Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	3.9.1	*Additional Dynamic Message Signs (DMS)* – Deploy Dynamic Message Signs along major state highways in the Baltimore and Washington, D.C. regions to provide comprehensive traveler information on roadways. Continue to extend DMS coverage statewide to include major state highways, as well as evacuation and Freeway Incident Traffic Management (FITM) routes.	1
			3.9.2	*Additional Highway Advisory Radio (HAR)* – Deploy Highway Advisory Radios along major state highways in the Baltimore and Washington, D.C. regions to provide comprehensive traveler information on roadways. Continue to extend HAR coverage statewide to include major state highways, as well as evacuation and Freeway Incident Traffic Management (FITM) routes.	2
			3.9.3	*Replace and Upgrade Highway Advisory Radio (HAR)* – Update the technology in existing highway advisory radio infrastructure to assure that this service continues to effectively broadcast current traveler information.	1
			3.9.4	*Replace and Upgrade Portable Trailer-mounted Dynamic Message Signs (DMS)* – Replace and upgrade existing portable DMS trailers with the latest technologies and wireless communications in order to provide flexible distribution of traveler information at any location. (This Strategy is repeated under Objective 13 as Strategy 3.13.1)	1

Element		Objective	Strategy		Priority
3	Traveler Information	9 - Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	3.9.5	*Replace and Upgrade Portable Trailer-mounted Highway Advisory Radios (HAR)* – Replace and upgrade existing portable HAR trailers with the latest technologies and wireless communications in order to provide flexible distribution of traveler information at any location. (This Strategy is repeated under Objective 13 as Strategy 3.13.2)	1
			3.9.6	*Infrastructure to Support In-vehicle Highway Hazard Alerts* – Deploy roadside detectors and short-range communication infrastructure to detect hazardous traveling conditions and exchange communications with traveling vehicles to alert motorists that will be affected.	3
			3.9.7	*Infrastructure to Support In-vehicle Highway Signage Systems* – Deploy short-range communication infrastructure to transmit data to a traveling vehicle in order to allow the motorist to see an in-vehicle display of upcoming static and dynamic signs, as well as other messages pertaining to motorist needs.	3
		13 - Enhance ability to manage traffic and increase safety near and within work zones and event locations.	3.13.1	*Replace and Upgrade Portable Trailer-mounted Dynamic Message Signs (DMS)* – Replace and upgrade existing portable DMS trailers with the latest technologies and wireless communications in order to provide traveler information messages at work zone and event locations. (This Strategy is repeated under Objectives 9 as Strategy 3.9.4)	1
			3.13.2	*Replace and Upgrade Portable Trailer-mounted Highway Advisory Radios (HAR)* – Replace and upgrade existing portable HAR trailers with the latest technologies and wireless communications in order to broadcast traveler information messages within work zone and event areas. (This Strategy is repeated under Objectives 9 as Strategy 3.9.5)	1
		16 - Develop additional capabilities within the CHART Operating System Software.	3.16.1	*Multi-modal Traveler Information Data Repository/Clearinghouse* – Develop a data repository/clearinghouse for CHART to make traveler information equally and readily available to any appropriate external organization desiring access (e.g., media and other private dissemination agencies).	1
			3.16.2	*Provide Data to support "Personal Subscription Services" for Traveler Information* – Develop public / private partnerships to process and package traveler information that is personalized using various technologies to identify the particular traveler and their predefined travel characteristics, such as routes, origins, destinations, and preferred modes.	1
			3.16.3	*Exchange/Integrate Multi-modal Data with/from Private Information Service Providers (ISPs)* – Software module deployment to request and integrate multi-modal traveler information data from a private traveler information clearinghouse or ISP, as well as to process multi-modal traveler information data into a pre-determined format for transfer to a private traveler information clearinghouse or ISP.	1
			3.16.4	*Exchange/Integrate Traveler Information Data with/from Other Public Agencies* – Software module deployment to request multi-modal traveler information data from various public agencies (within and outside of Maryland) and integrate it into the CHART system, as well as to collect and process multi-modal traveler information data within the CHART system into a pre-determined format for transfer to another public agency's system.	1

Element		Objective	Strategy		Priority
3	Traveler Information	16 - Develop additional capabilities within the CHART Operating System Software.	3.16.5	*Develop Traveler Information Software* - Software module deployment to provide added functionality to traveler information distribution and management capabilities within CHART software.	*1*

Element		Objective	Strategy		Priority
4	Traffic Management	10 - Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	4.10.1	*Support Statewide Traffic Signal System Optimization* – Support the development of a signal optimization plan and the deployment of new timings for signal systems operating MDSHA controlled arterials throughout the state in order to increase traffic flow.	*S-1*
		11 - Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	4.11.1	*Support Deployment of Ramp Metering* – Support the deployment of infrastructure to meter traffic flow onto freeways and expressways at access ramps in order to control the freeway's or expressway's operational level of service.	*S-2*
			4.11.2	*Support Deployment of Variable Speed Limit Systems* – Support the deployment of roadside devices along freeways and expressways that display changeable speed limits that are controlled by the CHART Operating System, in order to better control the freeway's or expressway's operational level of service.	*S-2*
			4.11.3	*Support Deployment of Lane Control Systems* – Support the deployment of various technologies that control the flow of traffic along freeways and expressways, including counter-flow lane control systems and dynamic HOV lanes, in order to better control the operational level of service.	*S-2*
			4.11.4	*Support Deployment of Queue Detection and Warning Systems* – Support the deployment of infrastructure to collect data in order to detect traffic queues at locations prone to congestion along freeways and expressways, and automatically warn motorists that will be affected.	*S-1*
			4.11.5	*Trail Blaze Signage* – Deploy infrastructure to provide signage to route vehicles along Freeway Incident Traffic Management (FITM) routes, or other pre-established diversion routes.	*1*
			4.11.6	*Highway Access Alert Systems* – Deploy infrastructure to alert motorists of travel conditions before reaching freeway or expressway access ramps.	*3*
			4.11.7	*Support Deployment of Dynamic Toll Lanes* – Participate in the establishment and operation of High Occupancy Toll (HOT) lanes and other advanced toll lane operations that dynamically toll travelers depending on various parameters (e.g., current congestion level and number of passengers in a vehicle) in order to better manage travel demand and traffic flow.	*S-1*

Element		Objective	Strategy		Priority
4	Traffic Management	12 - Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	4.12.1	*Support for Deployment of Traffic Management Infrastructure at Inter-modal Transfer Points and Major Parking Facilities* – Develop partnerships and deploy infrastructure to manage traffic flow as well as display real-time information at and approaching major parking facilities, including event parking and Park 'n' Ride facilities, in order to guide motorists to available parking.	*S-1*
		15 - Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.	4.15.1	*Support for Highway-rail Crossing Safety and Diversion Systems* – Support the deployment of infrastructure to process detection data at identified highway rail crossings and use technology applications to divert approaching traffic, as well as to predict collisions and alert motorists and/or train operators accordingly.	*S-2*
		16 - Develop additional capabilities within the CHART Operating System Software.	4.16.1	*Integrate Arterial Traffic Management Data* – Software module deployment to integrate available principal arterial traffic data into the CHART Operating System for use in traffic management and various other operations.	*1*
			4.16.2	*Develop Software to Manage Arterial Traffic* – Software module deployment to develop CHART's ability to control field devices in order to manage traffic along principal arterials (especially along FITM routes), and at principal arterial intersections with freeways and expressways.	*2*
			4.16.3	*Develop Traffic Management Software* – Software module deployment to provide added functionality to freeway and expressway traffic management operations within CHART software.	*1*

Element		Objective	Strategy		Priority
5	Systems Integration and Communication	1 - Enhance CHART's ability to visually monitor highway conditions	5.1.1	*Process Video Images for Traffic Information* – Develop "machine vision" technology to facilitate the collection of traditional video detection data (speed, volume, and occupancy), as well as data associated with visual detection of incidents.	*1*
			5.1.2	*Aerial Monitoring* – Identify and implement strategies which will provide CHART access to video images from cameras on airplanes and helicopters operated by various agencies in the Baltimore region, and extend aerial monitoring coverage to the Washington, D.C., Frederick, and Annapolis regions.	*3*
		3 - Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data and reduced infrastructure requirements.	5.3.1	*Integrate Traffic Probe Data* – Collect and integrate probe data collected by various technology applications in order to determine traffic flow conditions along freeways and expressways.	*1*
		6 - Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	5.6.1	*Support Regional Interoperable Incident Management Voice Communications* – Participate in the development of systems and software to establish interoperability between various agencies' voice communication systems to provide uniform communications between incident/emergency response personnel throughout a particular region.	*S-1*
			5.6.2	*Support Regional Incident Management Communication Networks* – Participate in the development and deployment of regional communication networks that access various public safety and transportation management databases, as well as provide real-time messaging capabilities between remote incident/emergency response personnel, in order to facilitate coordination and communications among various agencies responding to incidents and emergencies.	*S-1*
			5.6.3	*Support Integration of Regional Incident Management Systems* – Participate in the development and implementation of regional incident/emergency management networks that integrate independent agency systems in order to more efficiently manage various operations related to the detection, response, and clearance of incidents and emergencies throughout a region.	*S-1*
			5.6.4	*Geo-location Devices on Portable Incident/Emergency Management Equipment* – Equip MDSHA and other agencies' portable field equipment (including device trailers, tow trucks, incident management equipment, and FITM trailers) with geo-location devices in order to dynamically track and update exact locations and current usage status (e.g., direction facing) of field equipment being used for response to incidents/emergencies.	*1*

Element		Objective	Strategy		Priority
5	Systems Integration and Communication	8 - Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	5.8.1	*Statewide 511 Service* – Deploy necessary systems components to initiate a statewide 511 program that collects and manages available transportation-related data throughout the state and distributes information to travelers calling within the state using technologies such as audio-text and voice recognition.	*1*
		10 - Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	5.10.1	*Integrate Traffic Signal System Data* – Integrate the operation of traffic signal systems with SOC operations to automatically employ pre-arranged incident/emergency management timing plans for optimal traffic flow during incidents and emergencies, especially along Freeway Incident Traffic Management (FITM) routes.	*1*
		12 - Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	5.12.1	*Integrate Parking Management Data* – Collect and integrate parking management data from public and private parking institutions in order to improve parking traffic management operations through the CHART Operating System.	*1*
		13 - Enhance ability to manage traffic and increase safety near and within work zones and event locations.	5.13.1	*Geo-location Devices on Portable Work Zone/Event Equipment* – Equip MDSHA and other agencies' portable work zone/event equipment with geo-location devices in order to dynamically track and update exact locations and current usage status (e.g., direction facing) of field equipment being used for work zone or event management.	*1*
			5.13.2	*Geo-location Technology for Locating Work Zone Operations* – Deploy geo-location devices that will provide exact locations of work zone limits and other information to be integrated into the CHART Operating System for dynamic mapping purposes. Establish standardized methods for construction contractors to utilize geo-location equipment.	*3*
		14 - Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	5.14.1	*Security Measures for CHART Operations Centers and System Infrastructure* – Deploy infrastructure and systems applications that protect against unauthorized access to the CHART network, and user controls within operation center facilities.	*1*

Element		Objective	Strategy		Priority
5	Systems Integration and Communication	16 - Develop additional capabilities within the CHART Operating System Software.	5.16.1	*Develop Software to Provide Transportation Network Simulation and Prediction Capabilities* – Utilize simulation algorithms to analyze real-time traffic conditions and predict likely impacts on traffic flows as an operational decision tool.	1
			5.16.2	*Develop Software to Support CHART Performance Evaluation* – Collect and archive data related to the performance of the CHART program and analyze the data as an indicator of the program's effectiveness.	1
			5.16.3	*Further Develop Software to Predict Roadway Conditions During Adverse Weather Situations* – Software module deployment to improve the collection and processing of historical and real-time data from weather station field devices and thermal mapping applications in order to predict unsafe conditions along roadways.	1
			5.16.4	*Develop Map-based Graphical User Interface* (GUI) – Software module deployment to develop a customized map-based GUI for the CHART Operating System software to provide CHART personnel with accurate real-time geographical information to efficiently operate various CHART functions.	1
			5.16.5	*Develop Geographical Information System (GIS) Database for MDSHA Equipment Location* – Collect and develop GIS data for various permanent equipment locations (e.g., field devices, vehicle depots, cabinets, controllers, communications) to facilitate various operations through the use of a customized map-based GUI.	1
			5.16.6	*Develop CHART Portable Resource Tracking* – Software module deployment to facilitate CHART operations personnel's ability to track MDSHA and other agencies' portable field equipment (including device trailers, tow trucks, incident management equipment, and FITM trailers) in order to dynamically update exact locations and current usage status of available field equipment to be allocated when responding to incidents/emergencies.	1
			5.16.7	*Develop CHART Operator Decision Support* – Software module deployment to facilitate operational decision-making by providing several procedural options to a CHART staff responder that are based on predefined criteria, in order to better optimize incident/emergency and traffic management operations.	1
			5.16.8	*Develop Workstation Alert Subsystem* – Software module deployment to manage the distribution and display of alert messages (e.g., alerts from adverse weather detection devices) on workstations throughout the CHART network in order to assure that various types of alert messages are acknowledged, and by the appropriate personnel at the appropriate location.	1
			5.16.9	*Enhance Pager/Email/Fax/Cell Notification* – Update the existing software module to process notification messages for various operations and distribute them to the appropriate operational personnel or facility locations through the use of various predefined communication mediums.	1
			5.16.10	*Enhance Web Browser-based CHART Interface* – Update the existing software module that provides a Web browser-based interface to the CHART system to allow flexible and widespread access to CHART Operating System functionality.	1

Element		Objective		Strategy	Priority
5	Systems Integration and Communication	16 - Develop additional capabilities within the CHART Operating System Software.	5.16.11	*Integrate Traffic Probe Data*– Software module deployment to integrate into the CHART Operating System software traffic probe data collected through use of various technologies in order to determine traffic flow conditions along freeways and expressways and improve various CHART operations.	1
			5.16.12	*Exchange and Integrate Commercial Vehicle Operations (CVO) Data* – Provide, collect, and integrate data from and into commercial vehicle systems managed by state agencies and commercial operators in order to facilitate CHART's support of commercial vehicle operations along freeways and expressways.	1
			5.16.13	*Develop Access to Available HAZMAT Databases* – Initiate Maryland agency connectivity with national and state-level databases that provide information on HAZMAT carrier organizations and particular vehicles in order to better respond to incidents and emergencies involving hazardous materials.	1
			5.16.14	*Software for CHART System Health Monitoring* – Software module deployment to detect, locate, and track all failures, security breaches, and malfunctions within the CHART Operating System, communications network, or field devices.	1
			5.16.15	*Enhance Emergency Operations Reporting System (EORS)* - Continue to develop and improve the capabilities of the EORS network to improve incident/emergency operations throughout the state by overlaying data to and from CHART as well as Maryland Emergency Management Agency (MEMA) systems.	1
			5.16.16	*Develop Software for Control of Portable Devices* – Software module deployment to provide CHART personnel the ability to control portable field devices through the CHART Operating System.	1
		17 - Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	5.17.1	*CHART Communication Network Equipment Expansion* – Purchase and install additional equipment to support the expansion of the core fiber-optic Ethernet backbone.	1
			5.17.2	*Expand Communications to Local Agencies* – Extend communications to provide CHART data transfer capabilities with local jurisdiction agencies within Maryland.	1
			5.17.3	*SOC Integration and Equipment* – Plan, design, replace and upgrade equipment necessary to support the integration and inter-connectivity of CHART subsystems at the SOC.	1
			5.17.4	*Expand Communications to Adjacent States* – Extend communications with the necessary bandwidths to provide CHART data transfer capabilities with agencies' systems outside of Maryland.	1
			5.17.5	*Integrate Field Equipment Installations* – Deploy necessary communications, system components, and software updates to provide CHART data transfer capabilities with newly installed field devices and previously non-integrated legacy systems.	1

Element		Objective	Strategy		Priority
5	Systems Integration and Communication	17 - Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	5.17.6	*Deploy Secure Communications Between CHART Operations Centers and Emergency Management Systems* – Deploy secure and redundant communications to allow data transfer between CHART operations centers and various state, local, and federal emergency management agencies' systems to facilitate coordinated emergency management operations.	*1*
			5.17.7	*Increase CHART Network User Connections* – Deploy necessary hardware, software, and communications to provide transportation-related, public safety, and other appropriate agencies throughout the state access to the CHART system.	*1*
			5.17.8	*Wireless Communication Infrastructure* – Deploy necessary infrastructure to provide wireless communications with various field devices and other applications, including portable trailer-mounted devices, and permanent devices that present impractical circumstances for deploying wireline communications.	*1*
			5.17.9	*Satellite Communications Infrastructure* – Deploy necessary infrastructure to provide satellite communications for various CHART operations, primarily as a redundant source of communications for identified critical operations.	*1*

Element		Objective	Strategy		Priority
6	Emergency and Weather Operations	4 - Enhance CHART's ability to monitor travel conditions during inclement weather.	6.4.1	*Additional Weather Stations* – Deploy infrastructure at new weather and pavement condition monitoring sites to provide thorough statewide coverage.	1
			6.4.2	*Road Surface Monitoring Equipment on MDSHA Vehicles* – Equip Maryland State Highway Administration snowplows with technology applications that collect and transmit road surface condition data as the vehicle travels.	2
			6.4.3	*Automatic Vehicle Location (AVL) on Snowplow Vehicles* – Equip Maryland State Highway Administration snowplows with AVL devices to collect and transmit vehicle location data to support more efficient management of roadway treatment winter operations.	1
		7 - Enhance CHART's severe weather and emergency management operations.	6.7.1	*Traffic Monitoring Infrastructure Along Evacuation Routes* – Deploy permanent traffic detection and visual monitoring devices along evacuation routes in order to improve CHART operations during severe weather and emergency situations.	1
			6.7.2	*Support the Deployment of Bio-hazard/Radiological Detection Devices* – Support for deploying field devices along identified stretches of roadways and/or on critical infrastructure to detect biohazards or abnormal radiation levels and automatically warn CHART and other appropriate agency personnel.	S-1
			6.7.3	*Support for Emergency Operations Coordination* – Participate in coordination among transportation and public safety agencies to formulate emergency operations plans that would detail CHART's responsibilities for emergency response operations at the state or national levels. Coordination efforts would include CHART's connectivity with various emergency communication systems that provide a secure means of coordination and communications among responding agencies.	S-1
			6.7.4	*Traffic Management Infrastructure for Emergency Operations* – Deploy permanent infrastructure along evacuation routes (e.g., reversible lane signals, and route guidance signs) that will manage increased volumes of traffic using various technology applications.	1
			6.7.5	*Satellite Voice Communications for Field Emergency Operations* - Equip remote incident management personnel with portable satellite voice communication units to support redundant and continuous voice communications between field personnel and CHART operations centers during emergency situations.	1

6	Emergency and Weather Operations	14 - Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	6.14.1	*Security Monitoring Equipment for CHART Devices* – Continue to deploy infrastructure and equipment to increase security for CHART field equipment that is accessible to the public and is essential to continuity of CHART operations.	1
			6.14.2	*Security Monitoring Equipment for Critical Transportation Infrastructure* – Deploy technology applications that monitor identified critical transportation infrastructure to increase security measures in order to protect against sabotage and destruction.	1
		15 - Increase motorist roadway safety, and deploy systems to enhance safety at highway rail crossings.	6.15.1	*Support for Deployment of Flood Monitor and Warning Systems* – Deploy technology applications at locations identified as prone to flooding, in order to monitor flooding effects on road surface conditions and warn motorists of potential hazards.	*S-2*
			6.15.2	*Support for Deployment of Fog Monitor and Warning Systems* – Deploy technology applications at locations identified as hazardous due to recurring fog conditions, in order to monitor fog effects on traveling conditions and warn motorists of potential hazards.	*S-1*
			6.15.3	*Support for Deployment of High Wind Monitor and Warning Systems* – Deploy technology applications at locations identified as hazardous due to high wind conditions, in order to monitor high wind effects on traveling conditions and warn motorists of potential hazards.	*S-1*

Appendix C – Projects Grouped by Element

Element		Objective	Project		Cost ($)
1	Traffic and Roadway Monitoring	1 - Enhance CHART's ability to visually monitor highway conditions.	1.1.1.1	Deploy Additional CCTV Sites Along Freeways and Expressways	6,750,000
			1.1.1.2	Deploy Additional CCTV Sites Along Arterials	83,500,000
			1.1.1.3	Deploy Additional CCTV Cameras Along Freeway Incident Traffic Management (FITM) Routes	11,250,000
			1.1.2.1	Upgrade Existing CCTV Sites to NTCIP	178,500
			1.1.3.1	Deploy Video Detection Devices With CCTV Capability at Signalized Intersections	1,000,000
			1.1.4.1	Deploy Incident Monitoring Cameras on CHART Emergency Response Vehicles (This Project is repeated under Objective 6 as Project 2.6.5.1 - Costs reported here)	1,620,000
		2 - Enhance CHART's ability to collect automated traffic data from traffic detection sites.	1.2.1.1	Deploy Additional Traffic Detectors	24,600,000
			1.2.1.2	Deploy Additional Traffic Detectors Along Freeway Incident Traffic Management (FITM) Route	5,320,000

1	Traffic and Roadway Monitoring	3 - Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data, and reduced infrastructure requirements.	1.3.1.1	Purchase Portable Trailer-Mounted Traffic Monitoring Cameras (This Project is repeated under Objective 1 as Project 1.13.2.1 - Costs reported here)	600,000
			1.3.2.1	Purchase Portable Trailer-Mounted Traffic Detectors (This Project is repeated under Objective 1 as Project 1.13.3.1 - Costs reported here)	450,000
			1.3.3.1	Deploy Cellular Telephone Geo-Location Traffic Data Collection Infrastructure	155,000
			1.3.4.1	Deploy Toll Tag Traffic Probe Devices Along Roadways	4,000,000
		13 - Enhance ability to manage traffic and increase safety near and within work zones and event locations.	1.13.1.1	Deploy Permanent Traffic Monitoring Equipment at Work Zones	1,700,000
			1.13.2.1	Purchase Portable Trailer-Mounted Traffic Monitoring Cameras (This Project is repeated under Objective 3 as Project 1.3.1.1)	see 1.3.1.1
			1.13.3.1	Purchase Portable Trailer-Mounted Traffic Detectors (This Project is repeated under Objective 3 as Project 1.3.2.1)	see 1.3.2.1
		16 - Develop additional capabilities within the CHART Operating System Software.	1.16.1.1	CHART Virtual NTCIP Video Switch Interface	575,000
			1.16.1.2	Integrate CCTV with CHART connected agencies	444,000
			1.16.1.3	Integrate CCTV display with agencies not connected to CHART	190,000
			1.16.1.4	Support Display of Video to the Desktop at CHART Centers	500,000
			1.16.2.1	CHART Regional Traveler Information Clearinghouse Data Exchange	800,000
			1.16.3.1	Develop Standards-based CCTV Display and Control Software	550,000
			1.16.3.2	Develop Traffic Flow Monitoring Software	700,000

1	Traffic and Roadway Monitoring	16 - Develop additional capabilities within the CHART Operating System Software.	1.16.3.3	Develop Aerial Video Display Software	450,000
			1.16.3.4	Develop Incident Management Monitoring Software	1,200,000
			1.16.3.5	Develop Weather and Road Condition Monitoring Software	1,000,000
			1.16.3.6	Support Exchange and Integration of Work Zone/Evacuation Route Monitoring Software	860,000
			1.16.3.7	Develop Security Monitoring Software	475,000
		17 - Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	1.17.1.1	Integrate technology Refresh to Expand SOC Video Distribution	24,000
Element 1 Total Capital Cost Estimate					$97,716,500

Element		Objective	Project		Cost ($)
2	Incident Management	5 - Provide sufficient resources and training to operational personnel, and expand coordination with public safety agencies, to assure the efficient management of incidents and emergencies.	2.5.1.1	Purchase Incident Management Field Equipment for CHART Personnel	4,150,000
			2.5.2.1	Purchase Incident Management Field Equipment for Public Safety Agencies	980,000
			2.5.3.1	Provide Coordination and Resources for Training of Incident/Emergency Management Personnel	215,000
			2.5.4.1	Extend CHART Traffic Patrols	6,050,000
			2.5.5.1	Increase CHART Traffic Patrol in Existing Coverage Areas	340,000
			2.5.6.1	Deploy CHART Vehicle Depots	4,800,000
			2.5.7.1	Expand Coverage of CHART Traffic Operations Center (TOC) to all MDSHA Districts and Expand Existing Coverage	1,250,000
		6 - Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	2.6.1.1	Deploy AVL Technology in Future CHART Vehicles	896,000
			2.6.3.1	Deploy Portable, Real-Time Data Acquisition Devices for Operational Personnel	150,000
			2.6.4.1	Deploy Wireless, Real-Time Data Sharing Devices for Operational Personnel	150,000
			2.6.5.1	Deploy Incident Monitoring Cameras on CHART Emergency Response Vehicles (This Project is repeated under Objective 1 as Project 1.1.4.1)	see 1.1.4.1
		16 - Develop additional capabilities within the CHART Operating System Software.	2.16.1.1	Integrate Incident/Emergency Call Center and OnStar Incident Detection Notification Systems	140,000
			2.16.2.1	Develop AVL-Equipped Resource Tracking Software	1,350,000
			2.16.2.2	Develop Incident/Emergency Field Response Text/Data Communication Software	925,000

Element		Objective	Project		Cost ($)
2	Incident Management	16 - Develop additional capabilities within the CHART Operating System Software.	2.16.2.3	Develop Multi-jurisdictional CAD Operations Software	600,000
			2.16.2.4	Develop Multi-Jurisdictional Emergency Response Transportation Coordination Software	1,500,000
			2.16.3.1	CHART Incident Prediction Report Generation	1,100,000
			2.16.4.1	CHART Incident/Emergency Response Plan Generation	825,000
			2.16.5.1	Integrate Location Data from Wireless Enhanced 911 & #77 Information	460,000
			2.16.6.1	CHART Travel Condition Portal	560,000
			2.16.7.1	Develop Software for Multi-Modal Incident/Emergency Data Exchange	470,000
			2.16.8.1	Develop Software for Incident/Emergency Data Exchange for Highway Rail Crossings	397,000
			2.16.9.1	Develop Software for Incident Monitoring Cameras on Emergency Response Vehicles	300,000
Element 2 Total Capital Cost Estimate					$28,478,00

Element		Objective	Project		Cost ($)
3	Traveler Information	8 - Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	3.8.1.1	Develop Enhancements for CHART Web Site	550,000
			3.8.4.1	Deploy Electronic Traveler Information Board System	22,580,000
			3.8.5.1	Deploy AM/FM Side-Band Traffic Alert Infrastructure	945,000
			3.8.6.1	Purchase Commercial Radio Station(s)	9,000,000
		9 - Allow the traveling public to make better informed travel decisions by providing information on travel conditions via deployed highway field infrastructure.	3.9.1.1	Deploy Additional DMS Along Freeways and Expressways	7,000,000
			3.9.1.2	Deploy Additional DMS Along Arterials at Freeway Interchanges	25,000,000
			3.9.2.1	Deploy Additional HAR Along Freeways and Expressways	1,350,000
			3.9.2.2	Deploy Additional HAR Sites Along Arterials	1,350,000
			3.9.3.1	Deploy Replacement HAR at Existing Sites	500,000
			3.9.4.1	Deploy Replacement Portable Trailer-Mounted DMS (This Project is repeated under Objective 13 as Project 3.13.1.1 - Costs reported here)	1,120,000
			3.9.5.1	Deploy Replacement Portable Trailer-Mounted HAR (This Project is repeated under Objective 13 as Project 3.13.2.1 - Costs reported here)	150,000
			3.9.6.1	Deploy Roadside Infrastructure to Support In-vehicle Highway Hazard Alert	640,000
			3.9.7.1	Deploy Roadside Infrastructure to Support In-vehicle Highway Signage Systems	565,000

Element		Objective	Project		Cost ($)
3	Traveler Information	13 - Enhance ability to manage traffic and increase safety near and within work zones and event locations.	3.13.1.1	Deploy Replacement Portable Trailer-Mounted DMS (This Project is repeated under Objective 9 as Project 3.9.4.1)	see 3.9.4.1
			3.13.2.1	Deploy Replacement Portable Trailer-Mounted HAR (This Project is repeated under Objective 9 as Project 3.9.5.1)	see 3.9.5.1
		16 - Develop additional capabilities within the CHART Operating System Software.	3.16.1.1	CHART Archive	525,000
			3.16.2.1	Multi-Modal Traveler Information Web Services	437,000
			3.16.3.1	Develop Software to Exchange/Integrate Data with/from Private ISPs	454,000
			3.16.4.1	Develop Software from Traveler Information Data Exchange	400,000
			3.16.4.2	Integrate Traveler Information Data Exchange with MDOT Business Units	15,000
			3.16.4.3	Integrate Traveler Information Data Exchange with Local Agencies	50,000
			3.16.4.4	Integrate Traveler Information Data Exchange with Adjacent States	10,000
			3.16.4.5	Develop Software to Integrate Parking Management Data	530,000
			3.16.5.1	Develop Electronic Traveler Information Board Software	660,000
			3.16.5.2	Develop AM/FM Side-band Traffic Alert Traveler Information Software	540,000
			3.16.5.3	Develop Commercial Radio Station Traveler Information Software	800,000
			3.16.5.4	Develop Software for Field Device Traveler Information	800,000
			3.16.5.5	Develop 511 Traveler Information Software	1,500,000

Element		Objective	Project		Cost ($)
3	Traveler Information	16 - Develop additional capabilities within the CHART Operating System Software.	3.16.5.6	Develop Software for In-vehicle Traveler Information	900,000
Element 3 Total Capital Cost Estimate					$76,671,000

Element		Objective	Project		Cost ($)
4	Traffic Management	11 - Utilize current technology and strategies to optimize flow of traffic on access controlled highways.	4.11.5.1	Deploy Trail Blaze Signage for FITM Routes	1,200,000
			4.11.6.1	Deploy Highway Access Alert Systems	4,600,000
		16 - Develop additional capabilities within the CHART Operating System Software.	4.16.1.1	Integrate Data Related to Traffic Management Operations Along Arterials	675,000
			4.16.2.1	Develop Software to Incorporate Arterial Traffic Monitoring and Management into Freeway Operations	1,200,000
			4.16.3.1	Develop Software to Control Traffic Management Devices for Emergency Response/Evacuation Operations	800,000
			4.16.3.2	Develop Software for Operation of Ramp Metering Devices	650,000
			4.16.3.3	Develop Software for Operation of Variable Speed Limit Devices	750,000
			4.16.3.4	Develop Software for Operation of Lane Control Devices	740,000
			4.16.3.5	Develop Software for Operation of Queue Detection and Warning Devices	750,000

4	Traffic Management	16 - Develop additional capabilities within the CHART Operating System Software.	4.16.3.6	Develop Software for Operation of Highway Access Alert Systems	780,000
			4.16.3.7	Develop Software for Operation of Dynamic Tolling Systems	720,000
			4.16.3.8	Develop Software for Operation of Traffic Management Devices at Inter-modal Transfer Points	700,000
			4.16.3.9	Develop Software for In-Vehicle Highway Hazard Alerts	800,000
			4.16.3.10	Develop Software for In-Vehicle Highway Signage Systems	850,000
			4.16.3.11	Develop Software for Advanced Technology Traffic Detectors	850,000
Element 4 Total Capital Cost Estimate					$16,065,000

Element		Objective	Project		Cost ($)
5	Systems Integration and Communication	1 - Enhance CHART's ability to visually monitor highway conditions	5.1.1.1	Develop Software for Collecting and Processing Video Detection Data	850,000
			5.1.1.2	Integrate "Machine Vision" Technology into CHART	1,600,000
			5.1.2.1	Integrate Aerial Video Systems into CHART	120,000
		3 - Employ new technologies to monitor traffic and roadway conditions with greater accuracy, more data and reduced infrastructure requirements.	5.3.1.1	Integrate MDSHA Traffic Probe Data into CHART	250,000
			5.3.1.2	Integrate Traffic Probe Data from External Sources into CHART	470,000
		6 - Employ new technologies to improve CHART's coordination and communications during the management of incidents and emergencies.	5.6.4.1	Deploy Geo-location Devices on Portable Incident/Emergency Management Equipment	300,000
		8 - Allow the traveling public to make better informed travel decisions by providing travel conditions through various media sources.	5.8.1.1	Integrate Traveler Information Data for Statewide 511 Distribution	705,000
			5.8.1.2	Deploy Updated Telephone Switching System and Message Storage and Playback System	1,500,000
		10 - Enhance coordination between CHART and Traffic Signal Operations to optimize signal systems timing in response to conditions.	5.10.1.1	Integrate Traffic Signal Operation Systems into CHART	5,400,000

Element		Objective	Project		Cost ($)
5	Systems Integration and Communication	12 - Employ strategies to improve the efficiency of operations at inter-modal transfer points and parking facilities.	5.12.1.1	Integrate Parking Management Systems	160,000
		13 - Enhance ability to manage traffic and increase safety near and within work zones and event locations.	5.13.1.1	Deploy Geo-Location Devices on Portable Work Zone/Event Equipment	500,000
			5.13.2.1	Integrate Geo-Location technology into CHART	45,000
		14 - Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	5.14.1.1	Deploy Security Improvement Measures at CHART Operations Center	756,000
		16 - Develop additional capabilities within the CHART Operating System Software.	5.16.1.1	Chart Real-Time Simulation	1,350,000
			5.16.1.2	CHART Offline Simulation	400,000
			5.16.1.3	CHART Training Simulation	350,000
			5.16.2.1	CHART Reporting	500,000
			5.16.3.1	CHART Weather Alert Processing	700,000
			5.16.4.1	CHART Map-Based Graphical User Interface	1,000,000
			5.16.5.1	CHART GIS Database Enhancement	450,000
			5.16.6.1	CHART Resource Tracking Support	500,000

Element		Objective	Project		Cost ($)
5	Systems Integration and Communication	16 - Develop additional capabilities within the CHART Operating System Software.	5.16.7.1	CHART Operator Decision Support	740,000
			5.16.8.1	CHART Alerts	300,000
			5.16.9.1	CHART Notification	800,000
			5.16.10.1	Develop Enhancements for the CHART GUI	690,000
			5.16.11.1	CHART TSS Add Mobile Probe Data Device Type	347,000
			5.16.12.1	Integrate CVO Data	65,000
			5.16.12.2	Exchange CHART CVO data with Other Agencies	525,000
			5.16.13.1	Integrate HAZMAT Data	64,000
			5.16.13.2	Develop Software to Interface with HAZMAT Data Sources	525,000
			5.16.14.1	Develop Software for Monitoring the Status of CHART	1,508,000
			5.16.15.1	Develop Software for EORS	400,000
			5.16.16.1	Develop Software to Support IP Wireless Communications	400,000
			5.16.16.2	Develop Software for Portable/Trailer-Mounted DMS	225,000
			5.16.16.3	Develop Software for Portable/Trailer-Mounted HARs	650,000
			5.16.16.4	Develop Software for Portable Collection Devices	750,000

Element		Objective	Project		Cost ($)
5	Systems Integration and Communication	17 - Build the infrastructure necessary to expand the CHART Network and facilitate regional connectivity between operational facilities and to field devices.	5.17.1.1	Deploy Additional CHART Fiber Connections	6,600,000
			5.17.2.1	Deploy Communications to Local Agencies and Jurisdictions	200,000
			5.17.2.2	Integrate Communications to Local Agencies and Jurisdictions	500,000
			5.17.3.1	Integrate SOC Subsystems	350,000
			5.17.4.1	Deploy Communications Infrastructure with Adjacent States	20,000
			5.17.4.2	Integrate Communications Infrastructure with Adjacent States	90,000
			5.17.5.1	Integrate New Field Equipment Locations	8,500,000
			5.17.5.2	Integrate Radio Station(s) into CHART Operations	26,000
			5.17.6.1	Integrate Secure Communications to CHART Sites	240,000
			5.17.6.2	Emergency Backup Voice Communications between TOCs and Regional EOCs	51,500
			5.17.7.1	Deploy CHART Network Equipment at Public Safety and Transportation-related Agencies	250,000
			5.17.7.2	Integrate CHART Network Connections at Public Safety and Transportation Related Agencies	625,000
			5.17.8.1	Integrate Wireless Device Communications	647,000
			5.17.9.1	Deploy Satellite Communications for Redundant Communication Links	120,000
			5.17.9.2	Integrate Redundant Satellite Communications Links	320,000

Element	Objective	Project	Cost ($)
Element 5 Total Capital Cost Estimate			$44,434,500

Element		Objective	Project		Cost ($)
6	Emergency and Weather Operations	4 - Enhance CHART's ability to monitor travel conditions during inclement weather.	6.4.1.1	Deploy Additional Roadside Weather Stations	6,250,000
			6.4.2.1	Deploy MDSHA Snowplows with Road Surface Monitoring Technology	875,000
			6.4.3.1	Deploy Snowplows with Automatic Vehicle Location (AVL) Technology	9,000,000
		7 - Enhance CHART's severe weather and emergency management operations.	6.7.1.1	Deploy CCTV Devices Along Evacuation Routes	4,000,000
			6.7.1.2	Deploy Traffic Detection Devices Along Evacuation Routes	3,150,000
			6.7.4.1	Deploy Traffic Management Infrastructure Along Evacuation Routes	7,800,000
			6.7.5.1	Deploy Satellite Voice Communications for Field Emergency Operations	159,000
		14 - Enhance and expand transportation security measures to better protect systems and infrastructure against attacks and unauthorized usage.	6.14.1.1	Deploy Security Monitoring Equipment at Field Device Locations	3,000,000
			6.14.2.1	Deploy Security Monitoring Equipment at Critical Infrastructure Locations	2,600,000
Element 6 Total Capital Cost Estimate					$36,584,000
NCDP Total Capital Cost Estimate					$299,949,000

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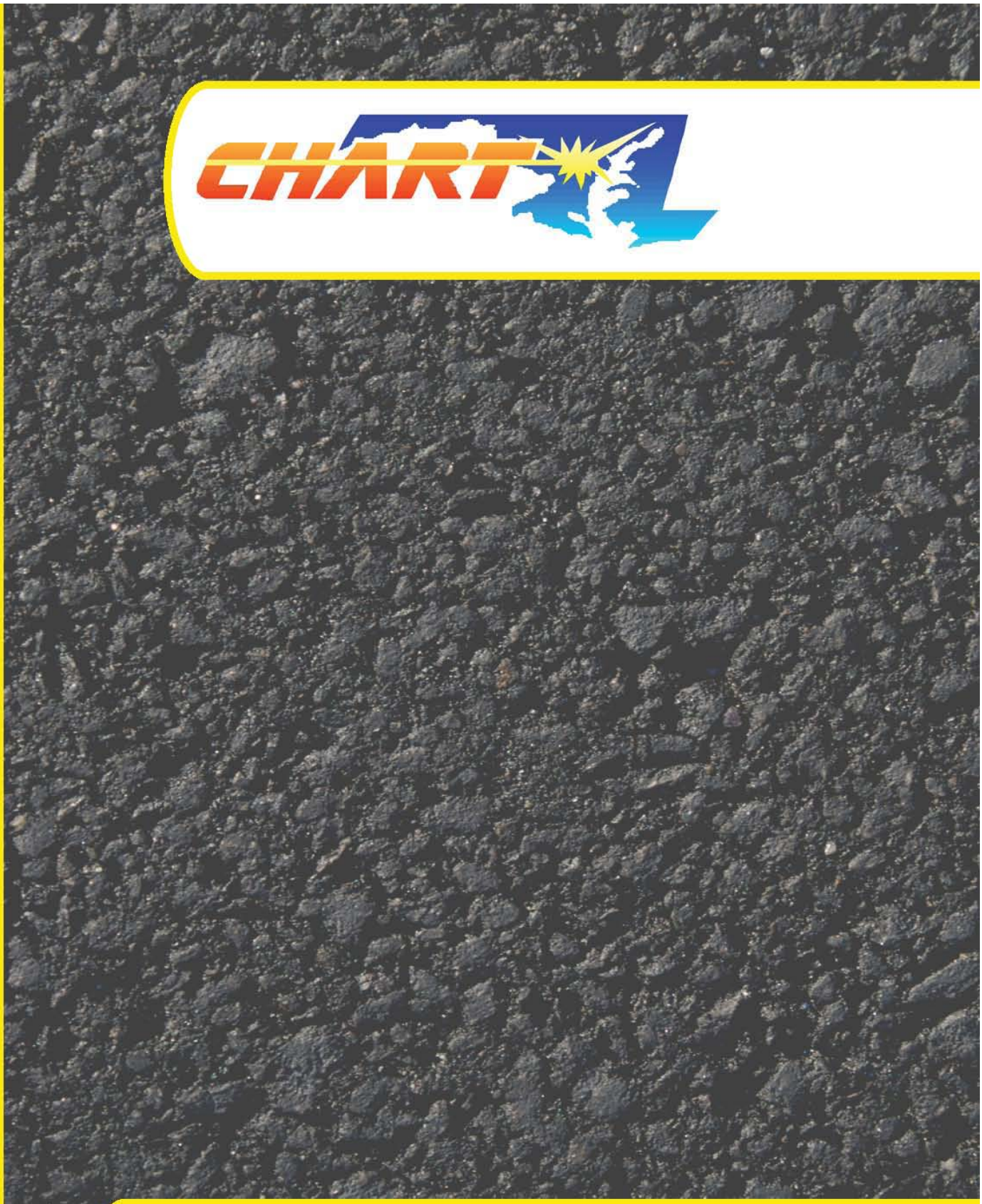
Appendix D – Project Definitions

This Appendix is intended to provide CHART management staff a set of deployable projects to meet the functionality described in the CHART NCDP Strategies and Objectives. Due to the large size of Appendix D – Project Definitions, it is not included in this primary document and, therefore, available upon request of CHART staff.

In Appendix D – Project Definitions -- each Project is defined through several different fields. These definition fields aim to provide a uniform manner of explaining what the deployment Projects will entail, as well as their importance in fulfilling CHART's goals. The fields are discussed in more detail below.

- Project Description – Gives detail on what will be implemented through the Project.
- Benefits – Presents qualitative benefits that will be realized through the implementation of the Project.
- Project Scale – Describes the level or extent of what the Project will implement. Can be described using measures such as geographical deployment areas, types of roadways, or number of devices.
- Technologies – Defines the technologies that will be implemented through the Project, as well as other technologies that will influence the implementation of the Project.
- Cost – Presents the estimated cost to implement the Project. (Note: leased communications necessary to operate additional CHART deployments are identified within the Project definitions. These recurring communications costs are included in the Project definitions to assist CHART in more specifically identifying costs for these Projects. However, for purposes of the remainder of the NCDP, the costs accrued by CHART to provide leased communications are incorporated in the overall operations and maintenance cost estimates, i.e., they are included as part of the 15 percent of capital costs considered operations and maintenance costs.)
- Related Strategies – Provides corresponding Strategies that will either support the deployment of the Project, or be supported as a result of deploying the Project.
- Cost Assumptions – Presents assumptions that were used to develop the Project cost estimate.
- 2005 NCDP Reference – Provides the linking Project number from the 2005 NCDP. If the Project is introduced by the 2008 NCDP (i.e., was not in the 2005 NCDP) the Project is labeled as "New".



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