

California Department of Transportation
Division of Research, Innovation and System Information

Research Manual



2014.2 Edition

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**California Department of Transportation
Division of Research, Innovation and
System Information**

Research Manual

**This document meets the requirements for the
State Planning and Research, Part II Program**

May 2014



Caltrans Division of Research,
Innovation and System Information

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I, Coco Briseno, Chief, Division of Research, Innovation and System Information, Department of Transportation, of the State of California, do hereby certify that the State complies with all requirements of 23 United States Code (USC) 505 and its implementing regulations with respect to the research, development and technology transfer program. I contemplate no changes in statutes, regulations, or administrative procedures that would affect such compliance.

A handwritten signature in blue ink that reads "Coco Briseno". The signature is written in a cursive, flowing style.

COCO BRISENO, Chief

Division of Research, Innovation and System Information

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Preface

The California Department of Transportation (Caltrans) Division of Research, Innovation and System Information (DRISI) manages a comprehensive portfolio of projects to address the research and operational needs across Caltrans. DRISI, in cooperation with our partners, provides solutions and knowledge that improve California's transportation system. These solutions and knowledge in methods, materials, and technologies enable Caltrans to promote safety, enhance mobility and sustainability, improve the management of public facilities and services, and protect public investment in transportation infrastructure.

This research manual provides researchers, Caltrans staff, academic partners, and others interested in the research program with the information needed to develop, select, fund, perform, manage, and deploy research that benefits the traveling public in California. This research manual also fulfills the United States Department of Transportation (US DOT) requirements to ensure the relevancy of Caltrans research in meeting national research goals.

An electronic copy of the Caltrans Research Manual is available online at:

<https://bit.ly/DRISI-Research-Manual>

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Section 1 Caltrans Research Program Overview

1.1 The Division of Research, Innovation and System Information

The Division of Research, Innovation and System Information (DRISI) manages a comprehensive program to research, develop, test, and evaluate transportation innovations sought by its customers.

These innovations in methods, materials, and technologies enable the California Department of Transportation (Caltrans) to promote safety, enhance mobility and sustainability, improve the management of public facilities and services, and protect public investment in transportation infrastructure.

DRISI seeks to take full advantage of strategic opportunities by identifying public and private partnering solutions. These partnerships leverage the dollars invested in present and future public infrastructure.

With direction from the Caltrans Executive Board, this is comprised of the Caltrans Director, District Directors and Headquarter Deputy Directors, DRISI:

- Establishes and facilitates the process to identify, select, program, manage, and deploy research
- Meets all federal-aid program requirements, including the preparation and maintenance of this research manual and the State Planning and Research (SP&R) Part II Annual Work Program (AWP)
- Establishes the research agenda based on the involvement and participation of its customers
- Develops and performs applied transportation research for all modes of transportation
- Provides technical assistance to its customers to implement transportation research products

- Engages in both short-term and long-term research
- Allocates funding for the research that includes leveraging national research funding from other transportation organizations and pooled funding opportunities

1.1.1 Caltrans Mission, Goals, and Values

Caltrans Mission

Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

Caltrans strives to be the highest performing transportation agency in the country. In pursuit of our mission, we continue to build a talented and diverse team, and we strengthen ties with our partners. To keep California moving, we commit ourselves to the following goals and values:

Caltrans Vision

A performance-driven, transparent, and accountable organization that values its people, resources and partners, and meets new challenges through leadership, innovation, and teamwork.

Caltrans Goals

Safety	Provide the safest transportation system in the nation for users and workers
Mobility	Maximize transportation system performance and accessibility
Delivery	Efficiently deliver quality transportation projects and services
Stewardship	Preserve and enhance California's resources and assets
Service	Promote quality service through an excellent workforce

Caltrans Values

Integrity	We promote trust and accountability through our consistent and honest actions
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- Commitment** We are dedicated to public service and strive for excellence and customer satisfaction
- Teamwork** We inspire and motivate one another through effective communication, collaboration, and partnership
- Innovation** We are empowered to seek creative solutions and take intelligent risks

1.1.2 Strategic Approach to Research

The research program development approach provides a framework for Caltrans and its partners to collaborate and to ensure research resources are directed to the most crucial needs.

This collaboration allows Caltrans to leverage research funds and provides guidance for partnering organizations that have common research needs, such as the Transportation Pooled Fund Program, the Transportation Research Board (TRB), and the American Association of State Highway and Transportation Officials (AASHTO).

The following tools also allow DRISI to address cross-functional research needs, and program-level research of the highest value:

- The Strategic Research Plan ensures selected projects are aligned with Caltrans' strategic direction.
- Research Roadmaps identify the research projects within a program area. DRISI annually updates the research roadmap for each program area.
- Research project plans identify the tasks and activities within a project that are needed over time to accomplish a research outcome. For a project plan example see appendix C.

1.1.3 Research Results

As a customer focused research program, the research projects will result in deployable products, which are research solutions that can be implemented by Caltrans and its partners.

These deployable products are:

- New or improved technical standard, plan, or specification
- New or improved manual, handbook, guidelines, or training
- New or improved policy, rule, or regulation
- New or improved business practice, procedure, or process
- New or improved tool or equipment
- New or improved decision support tool, simulation, model, or algorithm (software)
- Processed data/database
- Evaluation of new commercial products to determine if they meet Caltrans needs
- Other

Research projects are composed of tasks. Tasks end with deliverables and/or final reports that document the lessons learned, research results, and facilitate the technology transfer of the results.

1.2 Legal Authority for Research

1.2.1 Federal Laws

The federal law, "Moving Ahead for Progress in the 21st Century Act," also known as MAP-21, was signed into law on July 6, 2012. It outlines federal priorities for transportation research and authorizes funding for transportation research in the SP&R Parts I and II.

1.2.2 Federal Regulations

The authority for a state research organization to use federal funds is set forth in USC Title 23-Highways, Chapter 5 Research and Technology, Section 505. The authority for a state to administer SP&R funds, Parts I and II, is set forth in the Code of Federal Regulations, (CFR), Title 23, Part 420, Planning and Research Program Administration – 420.117 2(e), see [California Government Code website](#).

1.2.3 State Laws

The authority for Caltrans to perform research is set forth in California Government Code, Title 2, Division 3, Part 5, Chapter 4, Section 14452, see [California Government Code website](#).

Section 2 Research Program Development

2.1 Introduction

Caltrans has developed and implemented a coordinated process to identify research needs, conduct research, and deploy research results. The coordinated process is iterative and includes input from committees representing all functional areas of Caltrans and all levels of staff ranging from technical experts to executive management.

2.2 Caltrans Executive Board

Caltrans Executive Board advises DRISI of Caltrans strategic needs and priorities, and provides guidance on implementing research and new innovations.

The Executive Board draws on DRISI as a resource for options such as preliminary investigations, workshops, national programs, specialized transportation related conferences, and academic guidance.

2.3 Research Committees and Panels

DRISI's research process emphasizes customer participation along with effective deployment through customer ownership of the deployed research products.

The research committees are an important way of involving the customers in the research selection, project management, and implementation process. The related committees and panels are described briefly below.

2.3.1 Research and Deployment Advisory Committee

The Research and Deployment Advisory Committee (RDAC) advises DRISI on potential research objectives and priorities, recommends an annual program of research projects, and actively sponsors research products that are ready for implementation.

2.3.2 Program Steering Committees

The Program Steering Committees (PSC) are representatives from various Caltrans programs

requesting research. PSCs identify program-level research priorities, annually approve multi-year research roadmaps, and support implementation of research products.

2.3.3 Technical Advisory Panels

The Technical Advisory Panels (TAP) are composed of technical experts from Caltrans divisions, districts, DRISI, and external partners. They recommend research priorities and new research needs to the PSC and identify implementation opportunities.

The PSC, TAP, and DRISI relationship is shown in a PSC/TAP matrix.

2.4 Research Program Development Responsibilities

In support of the research program development, DRISI updates the Strategic Research Plan, and coordinates the selection process of the annual program of projects. Some of the responsibilities include:

- Providing staff support to the Executive Board and RDAC
- Advising the PSC and TAP
- Working with PSC and TAP to coordinate development of research roadmaps
- Preparing the annual program of projects
- Managing the contingency approval process
- Soliciting research proposals
- Coordinating Caltrans research activities with the University Transportation Centers (UTC) and with national transportation organizations such as TRB and AASHTO
- Leveraging partnered-research activities through Transportation Pooled Fund research

2.5 Funding Sources for the Research Program

The research program is funded by state and federal funds, reimbursed work, and grant funds.

2.5.1 State Funds

The principal source of state funding for Caltrans research is the State Highway Account (SHA). The state budget act authorizes the SHA, which is a transportation funding source generated from the state tax on motor vehicle fuels.

2.5.2 Federal Funds

The Federal Highway Administration (FHWA) SP&R Part II is the main federal funding source for Caltrans research. SP&R Part II is regulated by Title 23, CFR, Part 420, which identifies the administrative requirements that apply to the use of FHWA planning and research funds.

2.5.3 Reimbursed Work

Research projects are sometimes reimbursed through the request of a partner agency. Normally, this work is performed in conjunction with a state project or activity for the mutual benefit of the State and the partner agency.

2.5.4 Grant Funds

The FHWA, Federal Transit Administration (FTA), or other federal agency acting as research contracting parties, may negotiate with Caltrans (as the contractor) to conduct research through grant processes. Agreements of this kind typically provide 50 percent to 100 percent federal reimbursement of Caltrans costs.

2.6 State Planning and Research, Part II Annual Work Program

In order for the research program to expend federal funds, FHWA approval is required through the SP&R Part II Annual Work Program (AWP).

2.6.1 SP&R Overview

USC Title 23 Highways, Chapter 5 Research and Technology, provides for SP&R funding. Two percent of the total funds apportioned to the states each year, including California, are designated for planning and research activities.

Of this amount, not less than 25 percent must be spent on research, development, and technology transfer activities relating to highway, public

transportation, and intermodal transportation systems.

Federal funds typically provide for 80 percent of the cost of the research projects in the SP&R Part II AWP, and state funds provide for the remaining 20 percent. FHWA has the ability to waive the state match if the interests of the Federal aid highway programs are met by Title 23 CFR 420.119(d).

2.6.2 Caltrans SP&R, Part II AWP

DRISI reports to FHWA on the research projects and administrative costs that will be funded using the SP&R Part II AWP, as required by Title 23, CFR Section 420.111.

The SP&R Part II AWP is developed and approved before the beginning of each new state fiscal year. It describes the research work to be performed and estimated costs for that year.

Modifications to the SP&R Part II AWP may occur as a result of project scope and/or funding level changes. These modifications are transmitted to FHWA through amendments.

2.6.3 AWP Approval

The SP&R Part II AWP is submitted to the local FHWA Division Administrator for review and approval. No work shall begin prior to having approval by FHWA.

2.7 Additional Research Resources

Caltrans utilizes the National Cooperative Research Programs to leverage its financial and staff resources.

2.7.1 Transportation Pooled Fund Program

When significant or widespread interest is shown in solving transportation-related problems, research and technology transfer activities may be jointly funded by several federal, state, regional, and/or local transportation agencies, academic institutions, foundations, or private firms as a Transportation Pooled Fund study (TPF). For additional information on the TPF Program see [Transportation Pooled Fund Program website](#).

2.7.2 National Cooperative Highway Research Program

National Cooperative Highway Research Program (NCHRP) is administered by the TRB and sponsored by the member departments (i.e., individual state departments of transportation) of AASHTO in cooperation with FHWA.

NCHRP was created in 1962 as a means to conduct research in acute problem areas that affect highway planning, design, construction, operation, and maintenance nationwide.

Each state's allocation amounts to five and one half percent of its total SP&R apportionment and is set forth in supplementary tables issued with each year's Federal-Aid Highway apportionments.

Additional NCHRP information can be found at: <http://www.trb.org/NCHRP>.

2.7.3 Transit Cooperative Research Program

The Transit Cooperative Research Program (TCRP) was established under FTA sponsorship in July 1992.

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands.

Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The TCRP serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

Additional TCRP information can be found at: <http://www.trb.org/TCRP>.

2.7.4 Airport Cooperative Research Program

The Airport Cooperative Research Program (ACRP) was authorized in December 2003 as

part of the Vision 100-Century of Aviation Reauthorization Act.

The ACRP is sponsored by the Federal Aviation Administration and managed by the National Academies, acting through TRB, with program oversight and governance provided by representatives of airport operating agencies.

ACRP is an industry-driven, applied research program that develops near-term, practical solutions to problems faced by airport operators.

Additional ACRP information can be found at: <http://www.trb.org/ACRP>.

2.7.5 Hazardous Materials Cooperative Research Program

The Hazardous Materials Cooperative Research Program (HMCRC) focused on hazardous materials transportation was authorized in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users.

HMCRC is sponsored by the U.S. Department of Transportation (US DOT) Pipeline and Hazardous Materials Safety Administration and managed by the National Academies, acting through the TRB.

The HMCRC is intended to complement other US DOT research programs as a stakeholder-driven, problem-solving program, researching real-world, day-to-day operational hazardous waste transportation issues with near - to mid-term time frames.

Additional HMCRC information can be found at: <http://www.trb.org/HMCRC>.

2.7.6 National Cooperative Rail Research Program

The National Cooperative Rail Research Program (NCRRP) was authorized as part of the Passenger Rail Investment and Improvement Act of 2008. Program oversight and governance are provided by representatives of rail operating agencies, state departments of transportation and others.

NCRRP conducts applied research on problems important to freight, intercity and commuter rail operators. Research is necessary to solve

common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the rail industry

The NCRRP is sponsored by the Federal Railroad Administration and managed by the National Academies, acting through the TRB, with program oversight provided by an independent governing board including representatives of rail operating agencies, state departments of transportation, and others.

Additional NCRRP information can be found at: <http://www.trb.org/NCRRP/>.

2.7.7 University Transportation Centers

The UTCs are nationally-designated centers of excellence, fully integrated within institutions that serve as a vital source of leaders who are prepared to meet the nation's need for safe, efficient, and environmentally sound movement of people and goods.

The UTCs mission is to advance U.S. technology and expertise in the many disciplines comprising transportation through the mechanisms of education, research, and technology transfer.

The UTCs provide a critical transportation knowledge base addressing vital workforce needs for the next generation of transportation leaders at university-based centers of excellence.

2.8 Peer Exchange of the Research Program

Peer exchanges, as required under 23 CFR, Section 420.207(b), are a practical and effective tool to foster excellence in Research and Technology (R&T) program management. Peer exchanges provide an opportunity for participants to share best practices and management innovations through an open exchange of ideas, knowledge, and brainstorming.

A peer exchange is an information exchange among transportation research colleagues through which a host state may find the means

to restructure or fine tune research program processes.

Both staff and management from the host state and a group of invited top-level state and federal managers exchange information particularly relevant to the host state's R&T program over two to four days.

With periodic peer exchanges, a State's Department of Transportation (DOT) helps ensure that its research program remains viable, vibrant, and productive. When invited, Caltrans also participates in peer exchanges for other states and the FHWA.

2.9 FHWA Review of the Research Program

FHWA reviews all state programs for effectiveness and compliance with Federal-aid requirements for continued state certification. FHWA also ensures compliance with all federal laws, regulations, and policies.

Caltrans cooperates with the FHWA to ensure that these research program criteria meet the requirements under CFR, Title 23, Part 420, for the administration of planning and research funds.

Section 3 Research Project Development

3.1 Introduction

DRISI provides research solutions to California's transportation problems through its research projects. The research solutions are composed of deployable products that can be implemented by Caltrans or other public agencies. Each research problem, project, and solution is sponsored and supported by a Caltrans division and/or district.

3.2 Project and Task Definition

3.2.1 Project Definition

A research project typically consists of a sequence of tasks that result in a deployable product, as defined in Section 1.1.3.

3.2.2 Task Definition

Tasks are the building blocks for a research project. Some projects may only need one task, others may require multiple tasks.

Multiple tasks break up the research into logical partitions to create the deployable product, and offer an opportunity for the PSC to reassess the progress of the project at regular intervals.

3.3 Project Selection Process

The research selection process is composed of annual and contingency components.

3.3.1 Annual Research Cycle

Research funding requests are reviewed, prioritized, and approved both individually and by functional programs during the annual research selection cycle.

The annual research cycle provides an opportunity to reassess the strategic alignment of ongoing and planned research. DRISI's Annual Funding Request Process can be found in appendix D.

3.3.2 Contingency Approval Process

The contingency process provides an opportunity to consider research requests that are outside of the annual research selection cycle.

DRISI's Contingency Funding Request Process can be found in appendix E.

3.4 Project Preparation

3.4.1 Preliminary Investigations

Prior to initiating a research project, a Research Preliminary Investigation (PI) is performed. A PI is a literature review and identification of best practices in a specific field and function of the transportation system. The PI provides a comprehensive overview of historical and ongoing national and international work on a potential research problem.

Findings of a PI will indicate whether or not: a solution is available, relevant research is in progress that can be built upon, or new research is required. When new or additional research is needed, a research project is created.

3.4.2 Project Manager and Panel Roles

All research projects have a Project Panel. The role of the Project Panel is to guide the research project. The membership of the Project Panel is flexible and varies by the size and complexity of the project. At a minimum, the Project Panel consists of the research Project Manager (PM) and the customer representative.

If a project involves several functional areas or requires special expertise, the Project Panel should also include other experts to guide the project during the research activities. The Project Panel may have representation from academia, industry, non-government organizations, and local, state, and federal government. The research PM is the chair of the Project Panel and appoints all panel members, in consultation with the customer representative.

Activities

Project Panel activities may include:

- Developing the Project Plan
- Developing the scope of work for each task
- Working with researchers to monitor progress and facilitate the resolution of problems or delays
- Making recommendations to the PM regarding the selection of the contractor, project scope, budget, time modifications, and continuation of studies
- Reviewing the draft and final reports
- Recommending an implementation plan for research products (see section 6.3.2)

- How much time will the project require
- Who are the project champion(s) and/or sponsor(s)
- When will the deployable product be ready to use

3.4.3 Project Plan

Definition

A Project Plan is a dynamic tool that guides the PM and the stakeholders of the project in execution of the project. This plan explains why the research is being conducted, the anticipated outcome of the project, the perceived benefits of the project, and identifies what deployable product is anticipated, as defined in Section 1.1.3.

The Project Plan also conveys the current planning decisions made related to cost, schedule and scope, together with the constraints facing the project and what additional resources the project will require.

For large and complex projects, the plan may evolve over time based on completed project work, technology shifts, or social trends.

Purpose

The purpose of a Project Plan is to answer fundamental questions about the scope, cost, and schedule of the project, including, but not limited to the following:

- Why is the project necessary
- What are the deployable products upon completion of this project
- What are the tasks necessary to complete the project
- What are the benefits upon completion of the project
- How much will the project cost

Section 4 Research Project and Task Management

4.1 Management of Research

4.1.1 Project Manager

Responsibilities

The purpose of project management) in DRISI is to achieve the objectives of a research project on schedule and within budget. This project management process starts before any resources are committed and continues until all work is finished and the project is closed.

The PM is a Caltrans employee with full authority and responsibility to manage all aspects of an approved project. The PM is responsible for delivering the product on schedule, within budget, and to the satisfaction of the project's sponsors, customers, and end users.

Changing a Research Project

The need for a change in a research project can happen at any time after the project's initiation.

A research project may need to be changed due to new information being discovered, modifications in funding possibilities, or modifications in research priorities.

The steps to change a research project include:

- A recommendation from the Project Panel
- Approval from the related PSC
- Updating the Project Plan

Resource approval may also be necessary if additional time or funding is needed.

Canceling a Research Project

A project's circumstances can be significant enough to cancel a project. Cancellation can happen at any time during a project's life.

Canceling a research project goes through the same three steps as changing a research project. If a project task has been initiated, additional task termination work will be needed.

4.1.2 Task Management

Responsibilities

The Task Manager (TM) is responsible for overseeing the research task from task execution to close-out.

Task Execution

There are four mechanisms used to conduct research tasks within a DRISI research project. The four methods are:

- Contract Research
- In-House Research
- Transportation Pooled Fund Research
- National Cooperative Research Programs

Each method has its own execution criteria. See Sections 4.2, 4.3, 4.4, and 2.7, respectively, for additional information.

Task Reporting and Distribution

Quarterly reports for all active tasks are required throughout the life of the task. This report is done by each TM in the Research Project Management Database (RPMD). The RPMD is a database used to store, manage and report on the research program and projects.

A final report is created at the conclusion of each research task. The reports are distributed to the State, Federal, and National Depository Libraries.

Changing a Research Task

Requests for changes to a research task can come from a variety of sources. The change request is managed by the PM and TM working with the Project Panel and PSC.

Terminating a Research Task

When a decision has been made to terminate a research task, the TM will follow the DRISI Termination Report instructions and outline.

Task Close-out

When a task is completed, the TM will close the task in accordance with the research task close-out process and procedures.

4.2 Management of Contracted Research

4.2.1 Introduction to Research Contracts

The research contract allows Caltrans to utilize the expertise of universities and other transportation consultants.

The research contract is also the mechanism to encumber multi-year funding. This allows DRISI to provide better fiscal management of the research program.

The TM is typically responsible for all of the Contract Management duties for the contracts within their task. The various types of research contracts are:

- Standard Agreements
- Interagency Agreements
- Master Interagency Agreements
 - Research Technical Agreements
 - Task Orders
- Leverage Procurement Agreements
 - California Multiple Award Schedules, or CMAS
 - Cooperative Agreements
 - Master Service Agreements
 - Statewide Contracts*
 - State Price Schedule*

**Used primarily for purchase orders*

4.2.2 Executing Research Contracts

DRISI awards research contracts in accordance with approved Caltrans contracting procedures. The TM prepares all the documents necessary to execute each type of research contract.

4.2.3 Managing Contracted Research

Research contract management responsibilities extend from contract development to contract completion.

All Caltrans TM receive formal contract management training and must comply with the requirements in Caltrans “Contract Manager’s Handbook.”

4.3 Management of In-house Research

4.3.1 Introduction to In-house Research

In-house research differs from contracted research in that the researcher is an employee of Caltrans. The in-house researcher often also serves as the PM or TM.

In-house research enables Caltrans to:

- Give transportation administrators and managers accurate and substantive advice quickly, during emergencies or where problems being researched have safety implications
- Assess emerging research results and determine appropriate solutions to benefit California transportation programs
- Evaluate field-implemented transportation innovations for cost saving implications
- Provide a professional knowledge base to solicit, award, monitor, and evaluate the quality and cost-effectiveness of research

4.3.2 Requirements for In-house Research

Approval by DRISI management is required prior to starting in-house research.

In house researchers should possess the following:

- Expertise in the subject area of the research and the techniques to be used in the proposed research project
- Ability to dedicate the required amount of time to the research during the life of the project
- Ability to serve as liaison with the committees and panels identified in this research manual
- Approval by DRISI management

4.3.3 Execution and Management of In-house Research

The in-house researcher utilizes the NCHRP Report 20-45 “Scientific Approaches to Transportation Research”, NCHRP Report 727 “Effective Experiment Design and Data Analysis in Transportation Research”, and DRISI In-house Research Criteria.

4.4 Management of Transportation Pooled Fund Research

4.4.1 Introduction to TPF Research

The TPF Program allows federal, state and local agencies, and other organizations to combine resources to support transportation research studies.

The TPF Program is a popular means for State DOT, commercial entities, and FHWA program offices to combine resources and achieve common research goals.

Pooling resources reduces costs and provides efficient use of taxpayer dollars. It also provides greater benefits to participating interests as compared to individual entities conducting or contracting research on their own.

4.4.2 Involvement in Transportation Pooled Fund Research

When significant or widespread interest is shown in solving transportation-related problems, research, planning, and technology transfer activities may be jointly funded by federal, state, regional, and/or local transportation agencies, academic institutions, foundations, or private firms as a pooled fund study.

A federal or state transportation agency may initiate pooled fund studies. Regional and local transportation agencies, private companies, foundations, and colleges/universities may participate in pooled fund projects. TPF studies must be sponsored by either a state DOT or the FHWA.

For general information on Pooled Fund Projects see [Transportation Pooled Fund Program website](#).

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Section 5 Research Evaluation

5.1 Introduction

DRISI uses performance management and research project evaluation to more efficiently manage the research program and determine the program's overall effectiveness.

5.2 Research Program Evaluation

5.2.1 Performance Management

Performance management is a tool for diagnosing, solving problems, and maximizing opportunities. Performance management provides a framework that enables the DRISI research program to set realistic goals, focus on the most important challenges, and improve efficiency.

Performance management at DRISI is the ongoing process of establishing goals, selecting performance measures, evaluating the results, and closing the circle by reviewing and refining performance measures. The DRISI management team uses these evaluation tools to effectively manage the research program.

5.2.2 Performance Measures

DRISI measures products outcome, efficiency and stakeholder satisfaction types for its performance management.

5.3 Research Project Evaluation

Every research project will be subject to evaluation. The two major areas of the DRISI research project evaluation are continuing project evaluation and final project evaluation.

5.3.1 Continuing Project Evaluation

Continuous project oversight occurs throughout the life of every DRISI project and is formally performed quarterly with a project review occurring annually.

The purpose is to ensure that a project is achieving its stated objectives by remaining within scope, on schedule, within budget, to the satisfaction of the Project Panel and customers.

Quarterly Task Review

Caltrans research projects are performed using one or more tasks; therefore a basic mechanism for the quarterly evaluation is the task quarterly report. The TM is responsible for conducting the task quarterly evaluation and posting the results in the RPMD.

The PM is responsible for reviewing the information posted in the quarterly report(s), evaluating the project as a whole, and communicating the results to DRISI management and to the project customers.

The PM will evaluate whether or not the progress on the tasks requires changes to the research Project Plan. The PM's three basic recommendations to management are:

- Continue with the project as it stands
- Make changes in the project scope, schedule, or funding
- End the project

Annual Task Review

Annually each PSC will review their portfolio of projects and determine if each project should be continued, modified, or canceled. The Project criteria used for this effort will include:

- Financial performance as determined through the performance measures
- Success to-date in meeting the objectives according to the schedule as determined through the performance measures
- Potential for ultimately meeting the project objectives within scope, on schedule, and within the budget
- Potential risks impacting implementation
- Alignment of the project with the goals and priorities of Caltrans
- Availability of continued project funding

As part of the annual review, each PSC will work with the PM to update the Project Plan as necessary. The results of the each PSC annual review will be utilized (along with other information) by the RDAC in preparing the

Strategic Research Plan and Annual Program of Research Projects.

Project Review at Task Completion

When each task of a project is completed, there will be a formal review of the entire project to determine if the project should be:

- Continued as planned with the same scope, schedule, and budget
- Modified and continue with a changed scope, schedule, or budget
- Cancelled

The PM and the Project Panel will conduct the review and make recommendations to the appropriate PSC and DRISI management about the future of the project. The PSC and DRISI management will determine the course of the project, taking into consideration the recommendations of the PM and the Project Panel.

The criteria used to determine a project's future include, but are not limited to:

- Success in meeting the objectives of the completed tasks
- Successful delivery of all of the scheduled deliverables of completed and ongoing tasks as of the date of the review
- The project tasks are on-budget or under-budget as of the date of the review
- The PM and the Project Panel's assessment of risks for the project and their determination that there is a high probability for successful project completion
- Adequate future project funding exists
- The project continues to have a high priority for the PSC and for Caltrans
- Deployment and implementation potential

5.3.2 Final Project Evaluation

Completed Research Projects

Final evaluations are performed by the PM at the conclusion of each project. The PM will use the following questions to determine the lessons learned and success of the project:

- Were the objectives of the project met to the satisfaction of the customer and other stakeholders?
- Did the project produce all of the expected products?
- Have the customers formally verified and accepted the products produced during the research?
- Did the products meet all functional, performance, and quality specifications?
- Was the final research report written and accepted by Caltrans and the FHWA?
- Has the research report been distributed to appropriate depositories and stakeholders?
- Were the research methodologies used appropriate for the subject area?
- Was the project completed within the approved schedule?
- Was the project completed within the approved budget?
- If appropriate, are the research results in the process of being published in a peer reviewed journal?
- Are the anticipated benefits of the research being realized?
- Is the product being implemented by Caltrans, or by others?

The PM is encouraged to use quantitative analyses, such as cost reduction or crash reduction when appropriate, to evaluate the success of a completed project.

As part of the evaluation, the PM will recommend to DRISI management and the appropriate PSC if further research is needed.

Canceled Researched Projects

Research projects may be canceled as noted in the Section 5.3.1, Annual Task Review. Every canceled project will still be evaluated by the PM as part of the project closing process. The PM will review the project and recommend to the PSC and DRISI management whether or not to continue work in the research area with a new modified project.

Section 6 Research Implementation

6.1 Introduction

DRISI places emphasis on applied research as the means of developing innovations that can solve the problems facing the transportation infrastructure owners, operators, and users.

DRISI research also addresses transportation trends and policies that are driven by increasing demands, limited resources, and greater stakeholder expectations. Research results are most effective when completely implemented in the intended transportation environment.

Towards that goal, a well-developed research implementation strategy is needed to maximize the likelihood of implementing products of completed research.

6.2 Roles

6.2.1 DRISI Research Implementation Responsibilities

The PM, together with the Project Panel, the researchers, the customers, and the sponsors, guide the eventual implementation of research products throughout the research process.

6.2.2 Project Manager

The Project Manager (also see Section 3.4.2):

- Works with the customer representative, researcher, the Project Panel and DRISI to develop a detailed Implementation Plan. This plan provides the means for the customer to identify and document the necessary resources, processes, and requirements that will be needed to implement the product of the research
- Reviews and revises the Implementation Plan during the research process and throughout the life of the project
- Works with customers to evaluate and place the research in context with Caltrans operations
- Prepares a summary document of the problem studied, research findings, what they mean and how they should be used by Caltrans or other organizations, and their expected benefits

6.2.3 Researcher

The researcher plays an important role in the preparation of information, materials, and mechanisms needed to implement the research findings.

The researcher works with the PM to develop suitable mechanisms for implementation, and participates in technology transfer activities. Examples include presentations and training classes. The researcher may also participate in the development of marketing brochures, user manuals or other mechanisms appropriate for the implementation of the research results.

6.2.4 Customer Representative

The customer, typically a Caltrans Division or District, engages in the project throughout the research process. Customer participation is critical since the customer needs to assure that resources will be available to implement the new policy, practice, product, or service. Customers may be the end-user, a sponsor or a champion on behalf of another public entity.

6.3 Approach

The DRISI implementation approach is based on a gradual increase in customer involvement and ownership as the research moves through its progressive phases over time as it leads to the final product.

6.3.1 Implementation

Implementation describes the various activities that are required to put the product of a research project into widespread use. Implementation mainstreams a technology or innovation into an organization's standard operating procedure.

In the context of the DRISI research development process, implementation is the adoption of research products within the California transportation system infrastructure.

6.3.2 Implementation Plans

Implementation Plans are the documents that will be used to guide DRISI research towards the implementation of the research products.

Implementation Plans complement the Project Plans (See Section 3.4.3 Project Plan).

Implementation Plans help the PM and the Project Panel to identify the expected outcome and to develop a clear implementation strategy at the outset of the research process.

The scope, content and extent of the Implementation Plan is dependent upon a number of factors, including complexity of research, costs, risks, uniqueness, etc. For simpler projects, the Implementation Plan may

be a few pages, whereas for more complex projects, it will be more detailed.

6.3.3 Technology Transfer

Technology Transfer is the process by which research knowledge is communicated or shared by Caltrans.

Technology Transfer includes those activities that lead to the adoption of a new technique or product and can involve implementation, dissemination, demonstration, and training.

Appendices

Appendix A: Initialisms and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACRP	Airport Cooperative Research Program
AWP.....	Annual Work Program
Caltrans	California Department of Transportation
CFR.....	Code of Federal Regulations
CMAS	California Multiple Award Schedules
DOT	Department of Transportation
DRISI	Division of Research, Innovation, and System Information
FHWA.....	Federal Highway Administration
FTA.....	Federal Transit Administration
HMCRP.....	Hazardous Materials Cooperative Research Program
MAP-21.....	Moving Ahead for Progress in the 21st Century Act
NCHRP	National Cooperative Highway Research Program
NCRRP	National Cooperative Rail Research Program
PI.....	Preliminary Investigation
PM.....	Project Manager
PSC	Program Steering Committee
R&T	Research and Technology
RDAC	Research and Deployment Advisory Committee
RPMD	Research Project Management Database
SHA.....	State Highway Account
SP&R	State Planning and Research
TAP	Technical Advisory Panel

Appendix A: Initialisms and Acronyms, page 2

TCRP.....	Transit Cooperative Research Program
TM.....	Task Manager
TPF.....	Transportation Pooled Fund
TRB.....	Transportation Research Board
US	United States
USC.....	United States Code
US DOT	United States Department of Transportation
UTC.....	University Transportation Center

Appendix B: Definitions

Customer:	The customer typically a Caltrans Division or District, engages in the project throughout the research process. Customers may be the end-user, a sponsor or a champion on behalf of another public entity. (See page 15)
Deployable Product:	A deployable product is a research solution that can be implemented by Caltrans and its partners. (See page 2)
Implementation:	<p>The various activities that are required to put the product of a research project into widespread use. Implementation mainstreams a technology or innovation into an organization's standard operating procedure.</p> <p>In the context of the DRISI research development process, implementation is the adoption of research products within the California transportation system infrastructure. (See page 15)</p>
Implementation Plan:	Implementation Plans are the documents that will be used to guide DRISI research towards the implementation of the research products. (See page 15)
In-house Research:	In-house research differs from contracted research in that the researcher is an employee of Caltrans. The in-house researcher often also serves as the PM or TM. (See page 10)
Peer Exchange:	(Also known as Peer Review), an information exchange among transportation research colleagues through which a host State may find the means to restructure or merely fine tune research program processes. (See page 6)
Performance Management:	Performance management is a tool for diagnosing, solving problems, and maximizing opportunities. At DRISI performance management is the ongoing process of establishing goals, selecting performance measures, evaluating the results, and closing the circle by reviewing and refining performance measures (See page 13)
Performance Measures:	DRISI measures products outcome, efficiency and stakeholder satisfaction types for its performance management. (See page 13)
Preliminary Investigation:	A Research Preliminary Investigation is a literature review and identification of best practices in a specific field and function of the transportation system. (See page 7)
Program Steering Committees:	Program Steering Committees (PSCs) are representatives from various Caltrans programs requesting research. PSCs identify program-level research priorities, annually approve multi-year research roadmaps, and support implementation of research products. (See page 3)
Project:	A research project typically consists of a sequence of tasks that results in deployable products are research solutions that can be implemented by Caltrans and its partners. (See pages 2 & 7)

Appendix B: Definitions, page 2

Project Panel:	The Project Panel is flexible and varies by the size and complexity of the project. At a minimum, the Project Panel consists of the research Project Manager and the customer representative. The Project Panels purpose is to guide the research project. (See page 7)
Project Plan:	<p>A Project Plan is a dynamic tool that guides the PM and the stakeholders of the project in execution of the project. This plan explains why the research is being conducted, the anticipated outcome of the project, the perceived benefits of the project, and identifies what deployable product is anticipated.</p> <p>The Project Plan also conveys the current planning decisions made related to cost, schedule and scope, together with the constraints facing the project and what additional resources the project will require. (See page 8)</p>
Research Project Management Database:	The Research Project Management Database (RPMD) is a database used to store, manage, and report on the research program and projects. (See page 9)
Task:	Tasks are the building blocks for a research project. They break up the work needed to create the deployable product into logical partitions, and offer an opportunity for the PSC to reassess the progress of the project at regular intervals. (See page 7)
Technical Advisory Panels:	The Technical Advisory Panels (TAP) are composed of technical experts from Caltrans divisions, districts, DRISI and external partners. They recommend research priorities and research needs to the PSC and identify implementation opportunities. (See page 3)
Technology Transfer:	<p>Technology Transfer is the process by which research knowledge is communicated or shared by Caltrans.</p> <p>Technology Transfer includes those activities that lead to the adoption of a new technique or product and can involve information dissemination, demonstration, and training. (See page 16)</p>

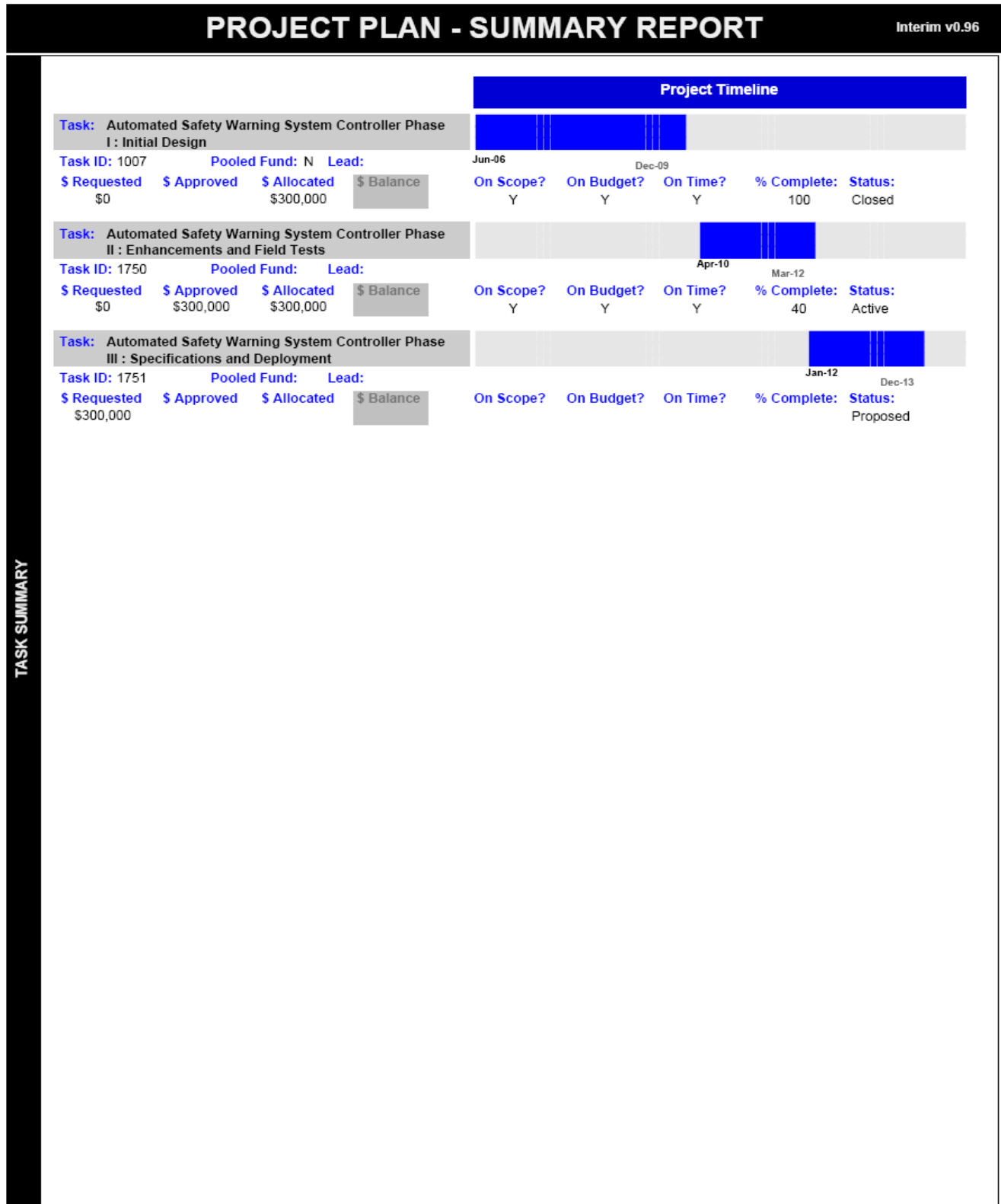
Appendix C: DRISI Research Project Plan Example (Referenced from page 2)

PROJECT PLAN - SUMMARY REPORT						Interim v0.96
STRATEGIC TIE	WBS: NO: P77	Title: Automated Safety Warning System Controller				
	Deployable Product/Service: A fully tested, District accepted, TEES ready, documented software installation package for an environmentally hardened embedded Linux system that can be easily configured to acquire sensor data from and send data to various roadside devices autonomously. The controller will activate various traveler information devices to notify the motorists of the roadway condition.					
	Goal: Safety SRQs: SF4 - Proactive Safety SF6 - Driver Behavior	PSC: Rural TAP: Rural Family: Rural Highway Conditions & Regional	Sponsor: Ed Lamkin Customer Rep: Ian Turnbull Project Mgr: Campbell, Sean Deploy Champ: Implem Champ:			
STATUS & FUNDING	Project Initiated in RPMD: 1/24/2008 Recommended by PSC: Initially Approved by RDSC: 8/18/2009	FY \$ Requested 12/13 \$100,000 13/14 \$150,000 14/15 \$50,000		FY \$ Allocated 05/06 \$80,530 06/07 \$147,963 07/08 \$71,507 08/09 \$0 09/10 \$75,000 10/11 \$150,000 11/12 \$75,000		
	Project Status: Approved Project Start Date: 6/15/2006 Project End Date: 12/31/2013					
	%Complete: Deployment Stage: 3 On Scope? Y On Budget? Y Updated as of: On Time? Y Qtr FY					
	TOTAL: \$300,000	TOTAL:		TOTAL: \$600,000		TOTAL:
PROJECT OVERVIEW	Background & Problem Statement: Automated warning systems are not a new concept within the transportation community. There are several projects on the state highway that use the concept of a roadway sensor initiating some type of motorist warning. To date, all of these systems are unique implementations that use one-of-a-kind software for control. The system controller is a custom device which can only be used with that particular project's physical and electrical layout. The department has benefited from a standardized approach to individual field elements such as Changeable Message Signs, Extinguishable Message Signs and detection loops. A standardized automated warning system controller, which controls standardized field elements in a system environment, has not been developed to date.					
	Description: Phase I - Initial Design : Determine the best platform to design the controller on. Determine initial user and system requirements. Design software based on initial requirements. Integrate lab prototype. Lab testing based on initial requirements. Field site determination, installation, testing and evaluation at four locations. Phase II - Enhancements and Field Tests : Focus on enhancements that are necessary based on results of Phase I. Deploy enhanced controller at existing field sites as well as other test sites throughout state. Evaluate enhanced controller based on rigorous testing criteria. Begin institutional policy change to garner statewide support for controller. Software and hardware documentation. Phase III - Specifications and Deployment : Create TEES standards and specifications for controller. Transfer technology from research partner to customer partners. Provide national exposure opportunities. Add controller to qualified products listing.					

Appendix C: DRISI Research Project Plan Example, page 2

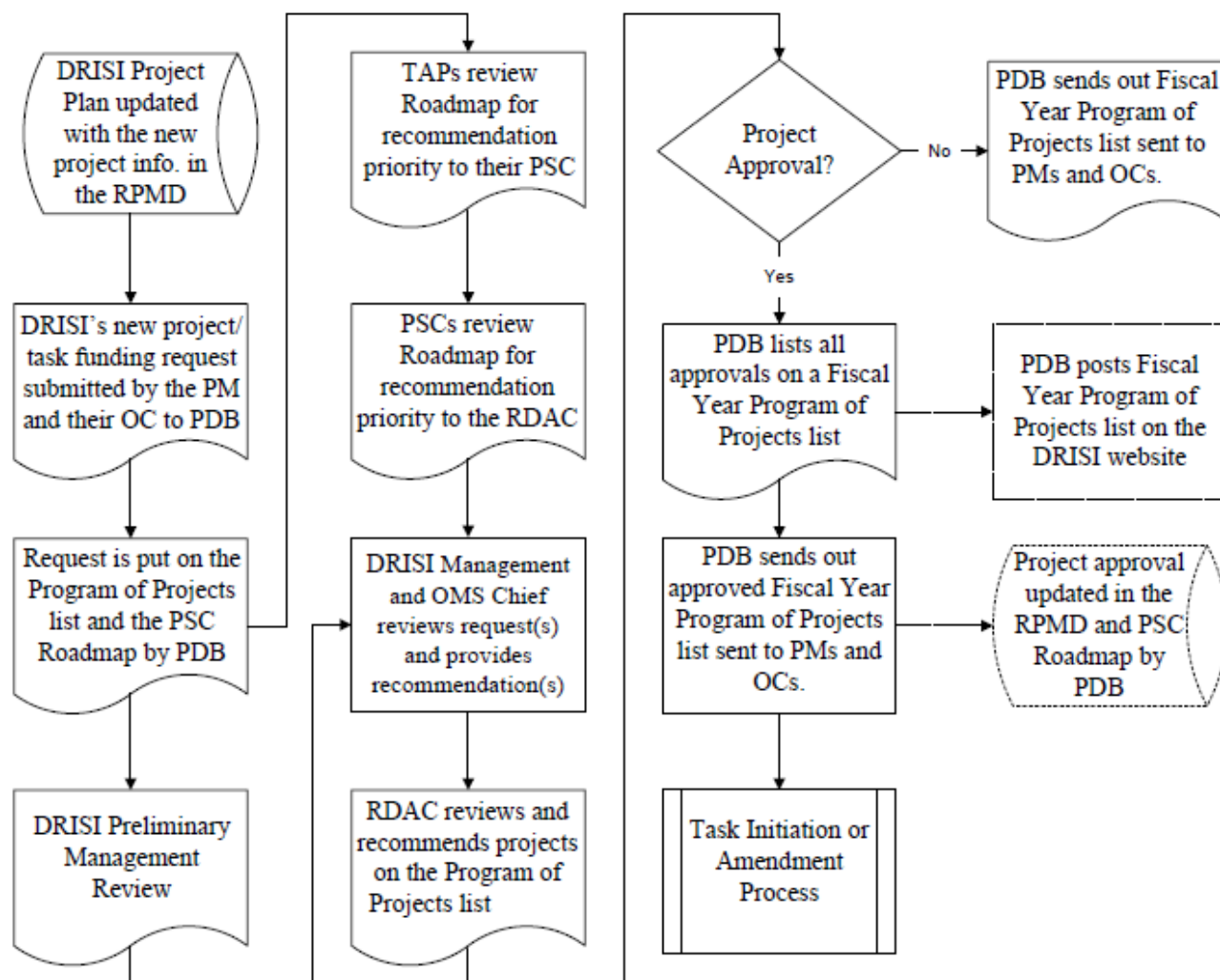
PROJECT PLAN - SUMMARY REPORT		Interim v0.96
PROJECT OVERVIEW	<p>Outcome:</p> <p>To influence driver behavior by presenting the motorists with proactive, timely, accurate roadway condition information. Using this information, the motorist can take appropriate action such as slowing down, pay greater attention to the roadway and be aware of conditions external to the vehicle.</p> <p>Benefits:</p> <p>Assists the Department's goal of reducing the fatality rate on the California state highway system. Reduces incidents on the rural highway network. Real time traveler information to the motorists.</p>	
	<p>Constraints:</p> <p>Intellectual property issues need to be worked through legal in order to deployed nationally.</p> <p>Additional Resources:</p> <p>District staff to undergo two-day training class. District to procure embedded Linux platform for each deployed location. DRI to support during lifetime of product.</p>	

Appendix C: DRISI Research Project Plan Example, page 3



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Appendix D: DRISI Annual Funding Request Process (Referenced from page 7)

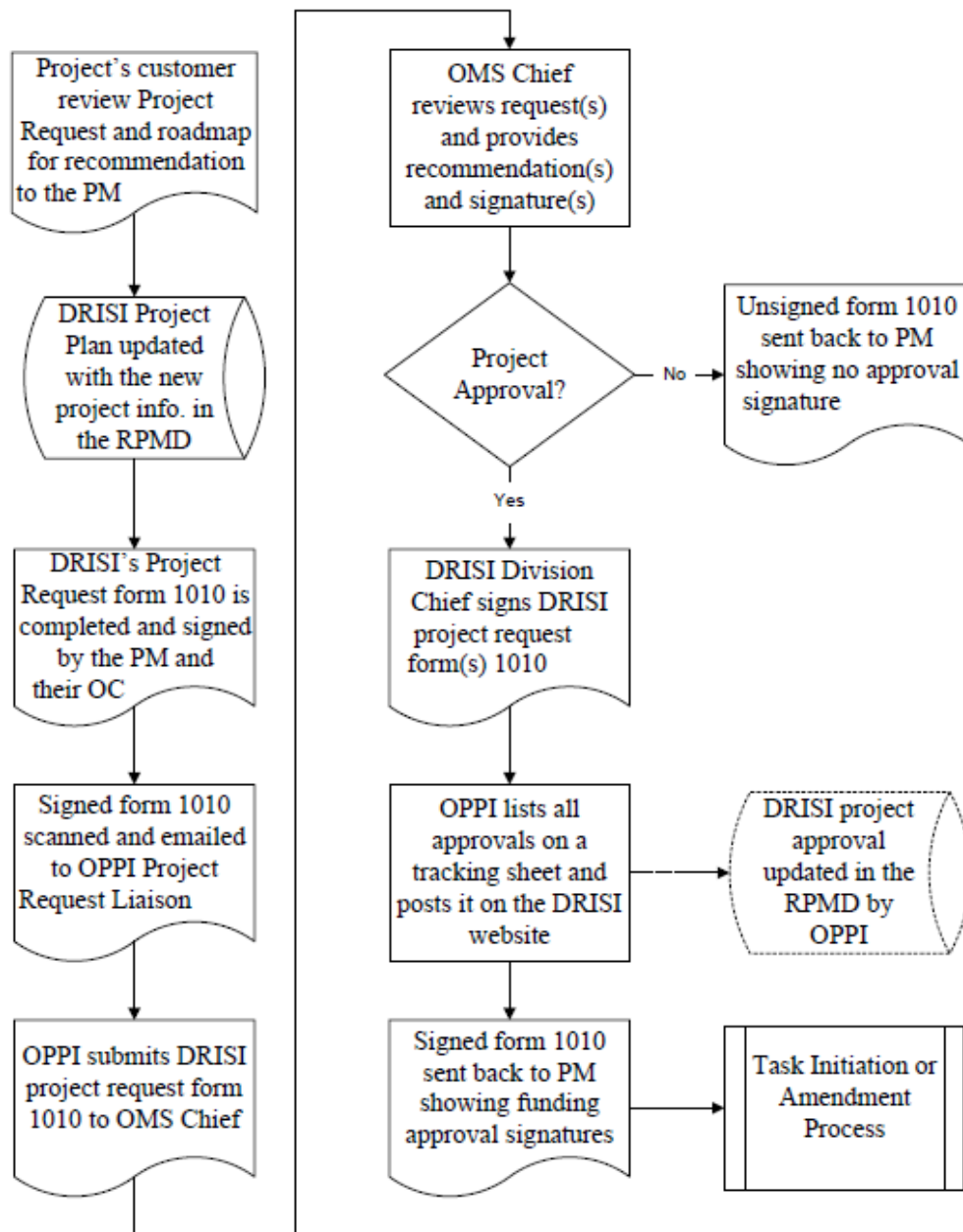


ACRONYMS

DRISI: Division of Research, Innovation and System Information
 RPMD: Research Project Management Database
 PM: Project Manager
 OC: Office Chief
 PDB: Program Development Branch
 TAP: Technical Advisory Panel
 PSC: Program Steering Committee
 RDAC: Research and Deployment Advisory Committee
 OMS: Office of Management Support

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Appendix E: DRISI Contingency Funding Request Process (Referenced from page 7)



ACRONYMS

DRISI: Division of Research, Innovation and System Information
 RPMD: Research Project Management Database
 PM: Project Manager
 OC: Office Chief
 OPPI: Office of Policy, Planning, and Innovation
 TAP: Technical Advisory Panel
 PSC: Program Steering Committee
 RDAC: Research and Deployment Advisory Committee
 OMS: Office of Management Support

Updated 5/20/2013

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