



U.S. Department
of Transportation
**Federal Highway
Administration**

Colorado Division
November 18, 2015

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Debra Perkins-Smith
Director, Division of Transportation Development
Colorado Department of Transportation
4201 East Arkansas Ave.
Denver, CO 80222

**Subject: Approval of the Department of Transportation Development Applied Research
and Innovation Branch Research Manual**

Dear Ms. Perkins-Smith,

As cited in the Code of Federal Regulations 23 Highways, 420.209 (b), documentation that describes the State DOT's management process and procedures for selecting and implementing research and development transfer activities must be developed and submitted to the FHWA Division office for approval. After reviewing the Department of Transportation Development (DTD) Applied Research and Innovation Branch (ARIB) Research Manual, completed on July 15, 2015, the FHWA Colorado Division finds it to be compliant with the federal regulations. This approval expires when a new document is created.

Any substantial changes to the current DTD Research Manual must be reviewed and approved by the FHWA Colorado Division.

If you have questions on any of the above regulations or procedures, please contact Aaron Bustow, Transportation Planner, at 720-963-3022 or via email at aaron.bustow@dot.gov.

Sincerely Yours,

John M. Cater, P.E.
Colorado Division Administrator

By: William Haas
Planning and Environment Team Leader

Cc: Amanullah Mommandi, CDOT DTD ARIB Director



COLORADO
Department of Transportation

Research Manual



Revised July 2015

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ACRONYMS

AASHTO - American Association of State Highway and Transportation Officials

ARIB – Applied Research and Innovation Branch

CDOT – Colorado Department of Transportation

DTD – Division of Transportation Development

FHWA - Federal Highway Administration

HITEC - Highway Innovative Technology Evaluation Center

ITRD – International Transport Research Documentation Database

LTAP – Local Technical Assistance Program

NCHRP - National Cooperative Highway Research Program

NTPEP – National Transportation Product Evaluation Program

OT - Oversight Team

PI - Principal Investigator

PS – Problem Statement

RFP – Request for Proposals

RAC – Research Advisory Council

RIC - Research Implementation Council

RD&T - Research, Development, and Technology

SOW - Scope of Work

SP&R - State Planning and Research

SME- Subject Matter Expert

TRB - Transportation Research Board

TRID – Transport Research International Documentation

TRIS – Transportation Research Information Services

1. INTRODUCTION

The Colorado Department of Transportation (CDOT) is a 1.4 billion dollar department of the state, dedicated to provide the best multi-modal transportation system for Colorado that most effectively and safely moves people, goods and information. Capital construction is about \$600 million dollars a year or half of the total budget. CDOT, with more than 3,300 employees and many public and private partners throughout the state, is responsible for multi-modal engineering, planning, and roadway maintenance for a 9,146 mile highway system, including 3,447 bridges, which handles over 27 billion vehicle miles of travel. Although the Interstate system accounts for only about 10% (914 miles) of the total mileage in the state system, 40% of all travel takes place on our Interstate highways. In addition, CDOT's Aeronautics Division supports Colorado's general aviation community through distribution of entitlement funds, an aviation grant program, and long-range system planning in partnership with Colorado's general aviation airports. CDOT's Division of Transit and Rail is responsible for the planning, development, finance, operation, and integration of transit and rail services into Colorado's overall transportation system.

1.1. Purpose of Manual

This manual describes the formal procedures under which research will be funded and/or conducted by CDOT. It is intended to meet the requirements as specified in 23 CFR Part 420, Subpart B, Research, Development, and Technology Transfer Program Management.

The objectives of this manual are to assure that

- A. priority and strategic issues are addressed by research, and
- B. research findings are useful and can be implemented.

2. CDOT VISION STATEMENT

“The vision of CDOT is to enhance the quality of life and the environment of the citizens of Colorado by creating an integrated transportation system that focuses on safely moving people and goods and by offering convenient linkages among modal choices.”

It accomplishes this by relying on its core values of safety, people, integrity, customer service, excellence, and respect.

2.1. CDOT Mission Statement

The mission of the Colorado Department of Transportation *is to provide the best multi-modal transportation system for Colorado that most effectively and safely moves people, goods, and information.”*

2.2. CDOT Strategic Focus Areas (Three Peaks)

Current CDOT management is emphasizing a three-pronged approach to becoming the best DOT in the country for our customers. Traveling the path of becoming the best DOT in the country requires a continued, even stronger customer focus. To this end, CDOT management established three “peaks” to reach:

1. Our people - growing and developing our team members so that everyone loves to come to work and others want to work for the best organization in Colorado and the country;
2. Leading edge technology - deploying the most leading edge technology to keep people moving more reliably and safely; and
3. Healthy multi-modal system - enhancing our roads, bridges and multi-modal options to get our customers where they need to go more safely, easily and more confidently than ever before.

2.3. Division of Transportation Development (DTD) Vision Statement

DTD is dedicated to excellence and innovation in developing solutions that best address Colorado’s diverse multimodal transportation system. We are committed to communicating and addressing the Department’s needs cross organizationally and with our external customers. We are vigilant in identifying opportunities for streamlining, partnering where we can to make a greater

impact in what we do, providing excellent customer service, and being good stewards of federal funds.

2.4. Division of Transportation Development (DTD) Mission

Working together with customers, DTD will provide information and recommendations that guide and influence transportation investment decisions by

- challenging current thinking to meet 21st Century needs,
- championing systems as well as projects that support the development of a multimodal system,
- linking creative ideas, products and technologies to programs and projects,
- collecting data and converting it into useable information to inform decision making,
- promoting and encouraging modal options,
- providing direct program support through advice or resource clearances,
- overseeing and staffing permit responsibilities for project delivery,
- improving accountability through performance-based activities, and
- developing and sharing expertise.

2.5. Applied Research & Innovations Branch Mission

“The mission of the Applied Research and Innovation Branch is to save Colorado citizens' money, time, and lives while preserving the environment and quality of life through the development and deployment of innovative products, materials, and methods in transportation.”

This mission is in part manifested through the review, selection and completion of research projects that reflect the CDOT and DTD missions, strategic areas, and goals.

3. ORGANIZATIONAL STRUCTURE

3.1. Research, Development, and Technology (RD&T) within CDOT

One of the most important items for an effective research branch, regardless of the location it occupies in the organizational structure, is supportive upper management. The current organization chart of CDOT is shown on Figure 1. The Division of Transportation Development (DTD) is shown on Figure 2. The Applied Research & Innovation Branch (ARIB) within the DTD is shown on Figure 3:

- The Manager of the ARIB reports to the Director of the DTD.
- The Director of the DTD reports to the Chief Engineer.
- The Chief Engineer reports to the Executive Director.

ARIB encourages maximum use of the expertise contained in the research branch by facilitating multi-disciplinary communications throughout the entire organization. The branch also encourages risk taking and innovative, out-of-the-box approaches to implementation and technology. The influence and endorsement of top management in the RD&T activities is a particularly effective lever for operating within the informal structure of the agency.

Organizational Chart

Updated December 2014

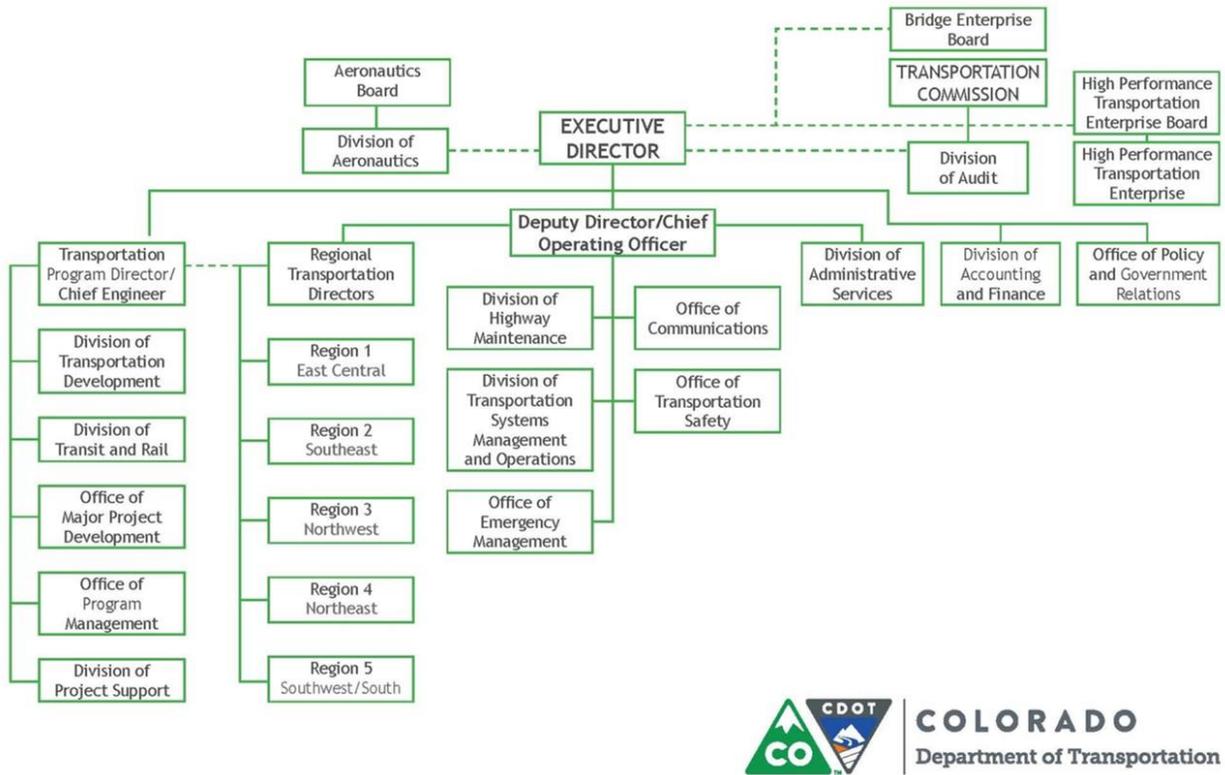


Figure 1 - CDOT Organizational Chart

3.2. DTD’S Organizational Structure

DTD is comprised of the Division Director’s Office and five major branches:

- Applied Research and Innovation,
- Asset Management,
- Environmental Programs,
- Information Management, and
- Multimodal Planning.

Within each branch, the work program identifies activities and deliverables that are intended to be undertaken and completed during a fiscal year. The projects listed in the work program are not all-inclusive; some activities are routine or do not result in a specific product. Figure 2 depicts DTD’s current organizational structure.

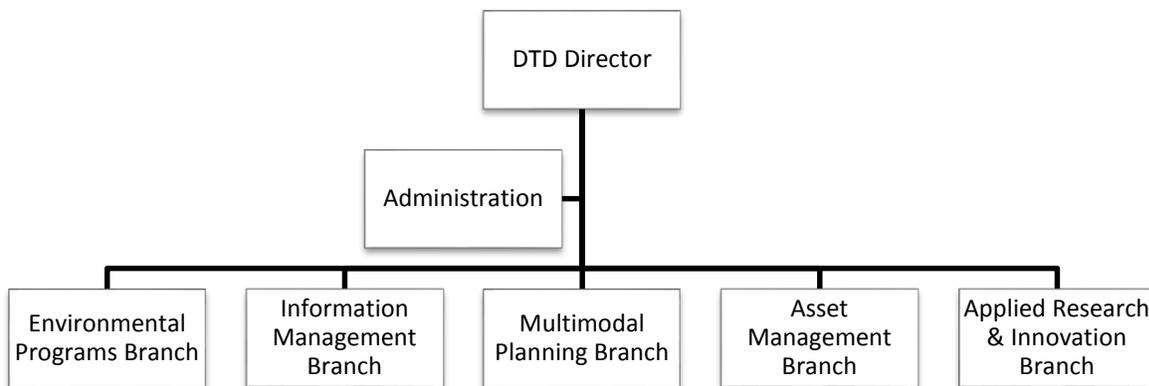


Figure 2 - DTD Organization Chart

3.3. Research Branch Organization

Following is the organizational chart for the Applied Research & Innovations Branch (ARIB).

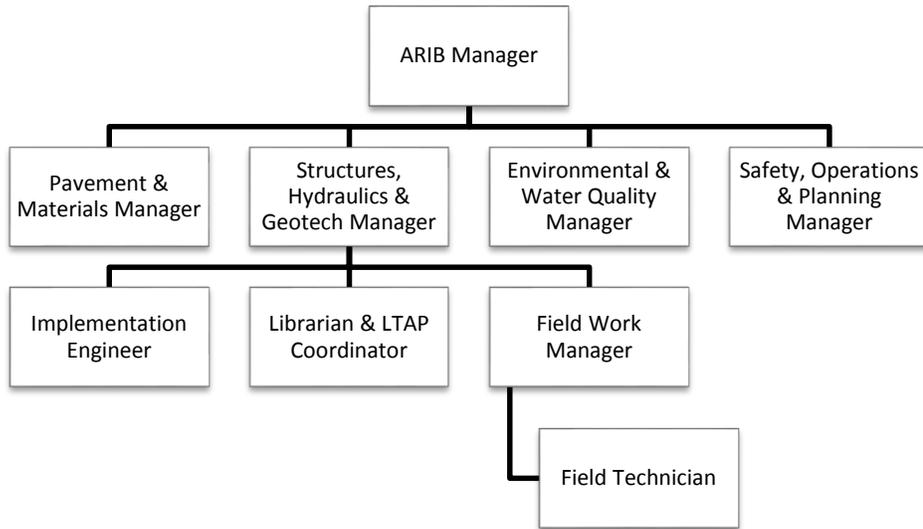


Figure 3 – Applied Research and Innovation Branch (ARIB) Organization Chart

4. APPLIED RESEARCH & INNOVATIONS BRANCH PROGRAM AREAS

Research can be formally defined as a systematic controlled inquiry involving analytical and experimental activities that primarily seek to increase the understanding of underlying phenomena. Research can be basic, or applied.

Applied Research – The systematic study of phenomena relating to a specific known need or practical application. The primary purpose of this kind of research is to answer a question or solve a problem.

Basic Research – The systematic study of phenomena without specific applications or products in mind. The primary purpose of this kind of research is to increase knowledge. Basic research lays the foundation for advancements in knowledge that may lead to applied gains in the future.

4.1. Research Program Areas

CDOT ARIB has been structured to have the following areas of specialty:

4.1.1 Environment and Water Quality

Identify research scopes, conduct research in-house and select consultants to do applied research in the areas of air and water quality, threatened and endangered species, vegetation management, noise abatement, NEPA processes, and sustainability. Using scientific research methods in the framework of interdisciplinary approach identify value added opportunities to minimize environmental impact of building and maintaining transportation infrastructure.

4.1.2 Structure, Hydraulic and Geotechnical

Identify research scopes, conduct research in-house and select consultants to do applied research in the areas of bridge and retaining wall design, slope stability and foundations, geology, hydrology, and hydraulics. Using scientific research methods and interdisciplinary approach identify value added opportunities to improve structural integrity of bridges, foundations, structures maintenance, cost-effectiveness of structural design, effectiveness of hydrological analysis, and hydraulic design of culverts and bridges.

4.1.3 Safety, Operations and Planning

Identify research scopes, conduct research in-house and select consultants to do applied research in the areas of highway safety, worker's safety, traffic operations, geometric design, transportation planning, maintenance, and ITS. Using scientific research methods in the framework of

interdisciplinary approach identify value added opportunities to improve safety, mobility, and effectiveness of the planning process.

4.1.4 Pavement and Materials

Identify research scopes, conduct research in-house and select consultants to do applied research in the areas of materials, pavement management system, and pavement design. Using scientific research methods in the framework of interdisciplinary approach, identify value added opportunities in the design, construction, and preservation of asphalt and concrete pavements, and in the use of binders, aggregates, fillers, emulsions, sealants, additives, geotextiles, reclaimed materials, supplementary cementitious materials, and other sustainable materials to improve the workability, performance, durability, and safety of pavement structures.

4.2. Research Management and Participation at the National Level

The management of the branch ensures its emphasis on relevance to practical needs of CDOT customers in concert with national participation through Transportation Research Board (TRB), AASHTO, FHWA and National Highway Traffic Safety Administration (NHTSA).

5. CDOT RESEARCH PROGRAM HISTORY

In 1962 US Congress passed highway legislation that required 1.5% of federal highway funds to be set aside for planning and research. CDOT (at that time known as The Colorado Department of Highways) began using these funds for research several years later. In 1965 the Research and Special Studies Section was established. Since 1965, research at CDOT has expanded from limited, special studies to a much broader scope now conducted by the Applied Research & Implementation Branch (see Appendix A).

The authority for the State research organization to use federal funds is found in 23 United States Code 307(c). The authority for the State to administer the SP&R funds in the program is found in 23 Code of Federal Register 420, Subpart B.

6. DEFINITIONS

AASHTO - American Association of State Highway and Transportation Officials

Founded in 1914, AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system involving air, highways, public transportation, rail, and water.

ARIB – Applied Research and Innovation Branch

The ARIB is responsible for the Research, Development and Technology (RD&T) program designed to conduct research that has a direct application to planning, design, construction, maintenance, and operations at CDOT. ARIB also facilitates the implementation of the research through knowledge, sharing, specification changes, and changes in practice.

Applied Research

Applied research studies phenomena relating to a specific known need in connection with the functional characteristics of a system to answer a question or solve a problem

Experimental Feature

An experimental feature study evaluates material, process, method, equipment item, or other feature that has not been sufficiently tested under real-world conditions to merit acceptance without reservation in normal highway construction; or has been accepted but needs to be compared with alternative acceptable features to determine merit and cost effectiveness.

FHWA - Federal Highway Administration

The Federal Highway Administration (FHWA) is part of the Department of Transportation (DOT) headquartered in Washington, D.C., with field offices across the United States. FHWA provides stewardship over the construction, maintenance and preservation of the Nation’s highways, bridges and tunnels. It also conducts research and provides technical assistance to state and local agencies in an effort to improve safety, mobility, and livability, and to encourage innovation.

The FHWA performs its mission through two main programs:

1. The Federal-Aid Highway Program provides federal financial assistance to states to construct and improve the National Highway System, urban and rural roads, and bridges.
2. The Federal Lands Highway Program provides access to and within national forests, national parks, Indian reservations, and other public lands by preparing plans, letting contracts, supervising construction facilities, and conducting bridge inspections and surveys.

To support these program areas, the FHWA conducts and manages a comprehensive research, development and technology program.

Final Report

Final reports are intended to provide documentation of all technical data, analyses, and findings for an entire project and to demonstrate fulfillment of the conditions of the contract. The final report should contain the training (if needed) for the research effort along with implementation recommendations.

HITEC - Highway Innovative Technology Evaluation Center

HITEC is a program conducted by the Civil Engineers Research Foundation with support from FHWA to investigate transportation applications of new technology developed by the private sector.

Implementation

Implementation is the process of putting research recommendations into practice. It is the adoption of a product for use, and includes Technology Transfer activities that promote adoption, such as information dissemination, training, demonstration, and deployment.

LTAP – Local Technical Assistance Program

LTAP is a national network of technology transfer centers (one in each state, one in Puerto Rico, and 7 that serve Native American Tribal Governments). The LTAP mission is to bridge the gap between research and practice through training and demonstrations for local transportation agencies, and by serving as a clearinghouse for information related to state-of-the-art technology in the construction and maintenance of roads and bridges. LTAP is funded by the FHWA, with matching funds from state governments, universities, state highway agencies, and other organizations.

NCHRP - National Cooperative Highway Research Program

A pooled fund program directed toward the study of problems of national significance that affect highway planning, design, construction, operation, and maintenance nationwide, NCHRP is administered by TRB and voluntarily sponsored by the member departments (e.g., individual State DOTs) of AASHTO. Each state's voluntary contribution amounts to 5.5 percent of its SP&R apportionment and can be spent only for the administration of problems approved by at least two-thirds of the states.

NTPEP – National Transportation Product Evaluation Program

NTPEP is an AASHTO program that evaluates materials, products, and devices of common interest for use in highway and bridge construction. The primary goals of the program are to provide cost-effective evaluations for state DOTs by eliminating duplication of testing and auditing by the states and duplication of effort by the manufacturers that provide products for evaluation.

Non-Expendable Equipment

Non-expendable equipment has a useful life of more than one year and an acquisition cost of more than \$5,000 per unit.

OT - Oversight Team

Oversight teams of experts and stakeholders established by the ARIB provide technical guidance and oversight for research in specific subject areas (refer to section 8 “Who’s Who in Research”).

Peer Exchange

“Peer exchange means a periodic review of a State DOT’s RD&T program, or portion thereof, by representatives of other State DOT’s, for the purpose of exchange of information or best practices. The State DOT may also invite the participation of the FHWA, other Federal, State, regional or local transportation agencies, the Transportation Research Board, academic institutions, foundations, or private firms that support transportation research development or technology transfer activities.” (23 CFR 420.203)

PI - Principal Investigator

The PI is the lead researcher who is responsible for the technical direction of the work on a study. The PI has the primary responsibility and is expected to be available and actively involved in the research efforts for the full duration of the project. In some research studies, more than one person shares responsibility of research as Co-Principal Investigator(s).

Pooled-Fund Studies

The Transportation Pooled Fund (TPF) Program allows federal, state, and local agencies and other organizations to combine resources to support transportation research studies. Pooled fund studies are used to jointly fund research, planning, and technology innovation activities. (Refer to section 8 “Who’s Who in Research” in this manual).

Proposal

A document is submitted by prospective researcher(s) to the OT in response to the RFP (see below). It defines the scope of work, budget, project schedule, deliverables, and qualifications of the research team.

PS – Problem Statement

The problem statement is a concise description of a problem or innovative idea that needs to be addressed through research. It must include the potential benefits of performing the research and implementation methods for the results. (Refer to Appendix E and F)

RFP – Request for Proposals

This term refers to the general process ARIB uses to select a PI to conduct research and write a final report; it is used in acquiring services and/or specialized products when objective bid specifications cannot be used. It can refer to a formal process managed by the procurement office where a panel of experts and stakeholders review proposals and select the one that is most

beneficial to the State. More commonly, it refers to a less formal process administered by ARIB to solicit university proposals and to select the best PI.

RD&T – Research, Development & Technology

A basic or applied research project or study, development or technology transfer activity (CFR 23 420.203).

RIC – Research Implementation Council

The RIC is composed of CDOT senior managers selected by the ARIB Manager; it includes representative(s) from the FHWA. The RIC reviews, evaluates, and selects research projects for funding based on CDOT’s Mission Strategy and Strategic Goals.

SAP - Systems, Applications and Products in Data Processing

SAP, the official system of record for CDOT, provides the integration of budgeting, accounting, resource management, personnel management, procurement, and project management. This software system is the means for initiating procurement and contracting, payment of invoices and contracts, and other tasks.

SME - Subject Matter Expert

The SME is recognized statewide by peers to be an expert in a specific area of the transportation program.

SOW - Scope of Work

The SOW is a formal document that describes and defines the research work activities, deliverables, cost estimate, and schedule needed to address the problem statement or research idea.

SP&R - State Planning and Research

Federal law requires two percent of federal-aid funds given to the states be apportioned for SP&R activities. Of these funds, a minimum of twenty-five percent must be allocated for research-related activities.

Study Manager

A CDOT employee, usually from the research branch, the study manager is responsible for overseeing the research study and coordinating activities with the study panel, the PI and various institutions. (Refer to Who’s, Who section)

Study Panel

An ad hoc committee consisting of the experts and stakeholders, a study panel is established to oversee a research study. It establishes the direction for the study to best meets the needs of CDOT. It reviews the work and reports of the PI and makes decision for implementations of research findings

Technology Transfer

Technology transfer consists of activities that lead to the adoption of a new technique or product by users and involves dissemination, demonstration, training, and other activities.

TRB - Transportation Research Board

One of six major divisions of the National Research Council, the TRB is a private, nonprofit institution that serves as a scientific and technical adviser to the President, the Congress and federal agencies. It is the principal operating agency of the National Academies of Sciences, providing services to the government, the public, and the scientific and engineering communities. TRB's mission is to promote innovation and progress in transportation through research and information exchange that is objective, interdisciplinary, and multimodal.

TRID - Transport Research International Documentation

The TRID integrated database combines the records from TRB's Transportation Research Information Services (TRIS) Database and the OECD's Joint Transport Research Centre's International Transport Research Documentation (ITRD) Database. TRID provides access to more than one million records of transportation research worldwide.

Work Program

The research branch work program is a document that describes the budget, projects and anticipated research studies for each fiscal year. The research work program is a sub-section of the DTD Work Program. The work program is updated and approved by CDOT and FHWA annually.

7. RESEARCH FUNDING SOURCES

The following are various categories of funding sources used to finance the CDOT research program:

- **SP&R Funds**

Most of CDOT's research effort is financed by SP&R funds. Current federal legislation requires that not less than 25 percent of the state's total apportioned SP&R funds shall be spent on research activities.

- **Federal Government Agencies**

Occasionally, the Applied Research & Innovation Branch will use matching funds for research projects from other federal agencies such as USGS.

- **State Funds**

Certain studies of limited scope or local interest can be financed with state funds.

- **Public-Private Partnerships**

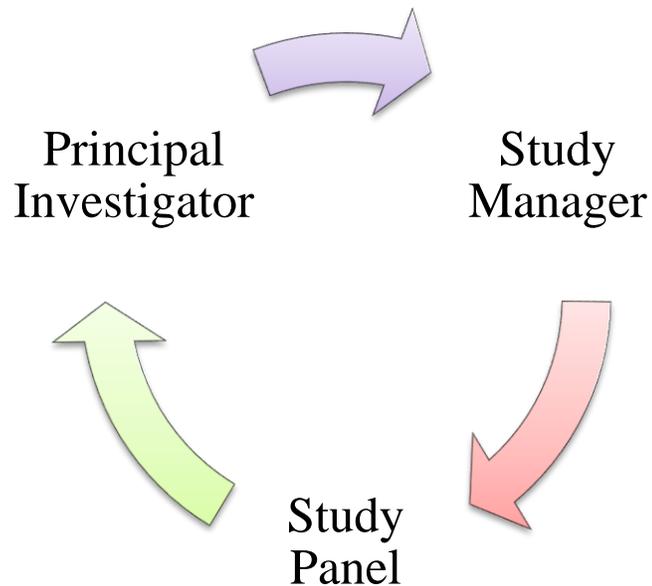
Public-private partnerships that will leverage research funding and enhance implementation opportunities are also pursued. Such relationships should be of benefit to Colorado's transportation program and in compliance with state and federal laws.

- **Other Funding Sources**

The ARIB may utilize other funding sources that may be available. Research performed by the CDOT staff with these funds, however, must still be consistent with the mission and goals of the department. The ARIB does not accept funding from sources that may put in question the impartiality of the research results.

DTD's primary program funding source is FHWA SP&R funds. Federal law requires two percent of federal-aid funds be apportioned for certain surface transportation categories and be spent on planning and research activities. Of these funds, a minimum of twenty-five percent must be allocated for research-related activities.

8. WHO'S WHO IN RESEARCH



Study Personnel consists of a Study Manager, a Study Panel, and a Principal Investigator. These personnel are responsible for insuring the study quality, timeliness, and finally, implementation of the research product.

8.1. Study Manager

The study manager is selected from the research branch staff and assigned to the project. The duties of the study manager make them the central contact point for all project activities. Ideally the study manager is the same individual that was assigned to evaluate the problem statements during the screening, prioritization and ranking process. This is not always practical but does create a cradle to grave management perspective to the initiative. The study manager coordinates with the appropriate technical advisory panel or project/study panel for the review of progress and final reports. Major responsibilities of the study manager are as follows:

1. Become familiar with the research project and related issues through literature reviews, discussions with other knowledgeable people on the subject, and consultation with the problem statement's author.
2. In cooperation with the RIC sponsor, assemble a study panel composed of at least two people from CDOT that are outside the research branch and have an interest in the defined problem. One of the members of the study panel should be the appropriate departmental subject matter expert. FHWA participation should also be solicited.

3. Organize, manage, and document the PI selection and hiring process. This includes drafting the SOW or RFP, working with the DTD Business Office to complete appropriate forms, soliciting for proposals, coordinating PI selection with study panel, negotiating the agreement with the PI and finalizing contract documents.
4. Keep the research project on schedule and track the project budget. Thoroughly review the project's activities and adherence to milestones.
5. Keep in contact with PI and relate any issues of concern to the study panel and RIC sponsor.
6. Consult with the RIC sponsor throughout the study. (See Functions of the RIC for RIC Sponsor role).
7. Conduct study panel meetings and keep study panel informed, as needed.
8. Maintain study panel member contact information.
9. Review and approve related project billings, and pay invoices as appropriate.
10. Remind PI two weeks before the deadline to provide the required progress report.
11. Inform panel members when new progress reports are available on the web site.
12. Coordinate and manage final report review, publication, and distribution.
13. Distribute Quick Study summaries to the Regions, when appropriate (Appendix B).
14. Coordinate the development, updating and finalizing of the implementation plan.
15. Finalize all financial records and reports.
16. Close out projects, especially pooled-fund projects.

8.2. Oversight Teams

The oversight teams (OTs) review and prioritize the proposals submitted for research study and determine whether the proposals comply with CDOT mission, vision and strategic goals. The OT's responsibilities include

1. review all research problem statements, except experimental feature evaluations and quick studies;
2. decide whether to support, enhance, combine, modify, or reject the problem statements;
3. create additional problem statements, especially when needed to address CDOT strategic direction in subject area;
4. make research funding recommendations;
5. provide guidance and support to RIC members; and
6. rank problem statements for RIC approval.

8.3. Oversight Team Manager (Research Manager)

The function of the oversight team manager is to

1. analyze problem statements or ideas received in OT subject area considering previous or ongoing research,

2. select OT members based on specialty areas that are related to the research,
3. schedule and facilitate the OT meetings and document all decisions,
4. modify problem statements when needed, and
5. assign study numbers and short title to each problem statement. (See Appendix H.)

8.4. Research Implementation Council (RIC)

The RIC reviews Colorado transportation research and development needs and recommends an RD&T program to meet these needs. Research projects are selected and prioritized annually by the RIC through a process that insures that a broad array of topics are included and that CDOT mission, vision, and strategic goals are addressed.

The members of the RIC are selected by the ARIB Manager with the objective of maintaining a proactive RIC that represents the broad needs of the transportation program. A representative from the Colorado Division of FHWA also participates on the council. RIC members from the regions are typically rotated every three years.

Each research subject area will have an appropriate RIC member who has the subject area authority within CDOT and will serve as sponsor and, in some cases, also champion for research in that subject area. RIC members will

1. provide support to the oversight team in their area of expertise for the first level of screening and prioritization of problem statements;
2. attend the annual RIC meeting to prioritize and rank problem statements;
3. review the study panel membership, the RFP, the PI, the final report, and approve the implementation plan; and
4. provide support to the ARIB and research champion for implementation of the research finding at the completion of the study.

8.4.1 Functions of the RIC Meeting

The ARIB Manager chairs the RIC meeting, which is held once a year, generally in the spring. The ARIB Manager may call for additional meetings if needed. During the RIC meeting, the RIC will

1. identify a strategic direction for the CDOT RD&T program with input from the oversight teams;
2. review proposed subject area recommendations presented by each of the oversight teams;
3. consider oversight team recommendations and the strategic needs and priorities of CDOT, in developing a prioritized list of research projects;
4. prioritize research project recommendations for funding;

5. recommend funding levels or a percentage of available funding to address ongoing activities, subject areas activities, and strategic area activities; and
6. provide guidance to oversight teams.

8.5. Study Panel

The functions of the study panel are to

1. attend and participate in panel meetings and provide technical expertise;
2. review the problem statement and, if necessary, refine or modify the objective of the research;
3. assist study manager with development of the SOW (Significant deviation from the problem statement or increase in funding is subject to ARIB Manager and RIC approval and funds being available.);
4. review and approve final SOW and RFP;
5. determine the domain of the PI; Possible domains include
 - a. CDOT staff;
 - b. public universities; and
 - c. all universities, private research groups, and consultants;
6. develop an RFP or in-house proposal as needed for approval by the appropriate RIC sponsor;
7. develop the selection criteria, including ability and commitment of the PI to produce an implementable product on schedule, for use in evaluating the proposals and in selecting the PI;
8. assist the study manger in issuing the RFP to the selected domain, if needed (Except for a CDOT staff PI, a competitive process for selecting the PI is required. If the study panel desires to include potential PIs that are not public universities, a formal bid or RFP process through the procurement office is required.);
9. select the PI based on the proposals received and the selection criteria;
10. review progress reports and notify study manager of emerging concerns;
11. review draft and final reports and provide comments in a timely fashion; and
12. provide input and review for the final implementation plan.

8.6. CDOT Research Champion

Every major project undertaken by the ARIB must have a dedicated champion. This has been shown over many years and by many organizations to have a significant impact on the chance for successful completion and implementation of the project results. In some cases the RIC sponsor will assign a project champion from their staff.

Projects without valid champions often fail to deliver usable products and in many cases fall short of the wide-spread acceptance needed within the organization. For this reason the study manager and research administrators should take the time and effort to ensure that an appropriate champion is located who is willing to commit to the tasks needed for a successful project.

The project champion should be knowledgeable about the technical aspects of the topic, have an understanding of the scope of the undertaking within the industry, and be a key stakeholder in the success of the project. The main role of the champion is to dedicate the time and resources needed to help the PI and PM toward the successful completion and use of the initiative.

Responsibilities of the research champion include, but are not limited to

1. work with the individual(s) initiating a problem statement to develop the research idea and potential solution;
2. coordinate with the ARIB Manager to finalize the problem statement;
3. coordinate with ARIB Manager to prepare a presentation to RIC for project approval;
4. work with ARIB Manager to finalize the SOW and select a PI,
5. act as the study panel leader and work with the panel members to review the progress of the research;
6. provide appropriate support to the PI conducting the research effort;
7. review draft and final reports with other study panel members;
8. coordinate with the PI to prepare a final presentation of the research finding to the panel members for final review and approval; and
9. most importantly, coordinate the implementation of the research findings (when appropriate) with ARIB, the study panel, the PI and the relevant department at CDOT.

8.7. Principal Investigator (PI)

The functions of the PI are to

1. complete the research according to the Scope of Work, as scheduled and within budget,
2. identify immediately to the study manager any issue that could impact the SOW, expected outcome, schedule, or cost of the project,
3. attend all panel meetings,
4. provide progress reports at the end of each calendar quarter to the study manager.
5. provide draft final report to study manager at least two months before the project is expected to conclude,
6. address all comments on the draft report made by the study panel,
7. provide a final report that follows the required report format for editorial review (See Appendix C "Research Report Format"), and
8. make editorial corrections and submit the final report electronically. Any graphics included in the report need to be distinctive, and understandable.

8.8. CDOT Research Librarian

The CDOT Library has the most comprehensive collection of transportation reference materials in Colorado. The catalog of 20,000 items is available to the department online through CDOT's network. It is located at CDOT Headquarters in the Shumate Building. The library is open to CDOT employees and the general public during business hours Monday through Friday. The library's holdings include AASHTO and TRB publications, research project reports from many sources, and career/personal development materials, available on CDs, DVDs, and as computer references. The Staff Librarian will perform customized transportation literature searches on request. The librarian is responsible for

1. cataloging and stocking books, videos, reports, and CDs;
2. updating and maintaining the CDOT research website at <http://www.coloradodot.info/programs/research>;
3. formatting and publishing all CDOT research final reports (Refer to Appendices C and D for report formats.);
4. conducting literature searches for ARIB projects; and
5. managing the LTAP program for CDOT.

8.9. ARIB Manager

The ARIB Manager is responsible for the RD&T program for CDOT and is the person that controls CDOT's ARIB participation in the federal-wide RD&T program as defined and required by federal guidelines. Responsibilities of the ARIB Manager include

1. making recommendations to the CDOT Executive Director regarding RIC membership;
2. polling RIC membership and executive management regarding changes to the research strategic direction and call for a RIC meeting if changes are needed;
3. providing information to executive management and the RIC as needed to facilitate their decision-making;
4. with the research strategic direction as a guide, soliciting problem statements from all CDOT employees, Colorado universities, MPOs, and the FHWA prior to annual RIC meeting;
5. assigning received problem statements to the appropriate research oversight teams,
6. reviewing research oversight team recommendations for completeness and distributing them to the RIC members;
7. calling for and chairing RIC meetings to review and prioritize research oversight team recommendations;
8. calling for and chairing additional RIC meetings, if needed;
9. compiling RIC recommendations and reviewing them with the Director of DTD and the Chief Engineer;

10. developing annual RD&T work program based on RIC recommendations and presenting it to DTD management;
11. assigning funded RIC approved projects and experimental feature projects to study managers based on expertise and workload;
12. approving final study plan for each project;
13. amending current RD&T work program as needed;
14. reviewing implementation plans and forwarding them to the RIC after approval by the study panel and the implementing office;
15. providing overall management of the RD&T program and staff;
16. coordinating CDOT research activities with other DOTs, FHWA, TRB, and AASHTO;
17. managing research projects of special significance to CDOT executive management; and
18. closing out completed projects, especially pooled-fund projects.

8.10. Director of DTD

Functions of the Director of DTD as Related to the RD&T Program **are to**

1. participate in the development of the research strategic direction,
2. review RIC recommendations and make necessary adjustments in cooperation with the Chief Engineer,
3. review and approve the overall SP&R Work Program including the RD&T part,
4. submit the SP&R Work Program, in cooperation with the CDOT Executive Director and the Transportation Commission, to the FHWA Division Office for approval, and
5. review and approve contract, task orders and purchase orders for research projects.

8.11. DTD Leadership Team

Functions of DTD Leadership Team as Related to the RD&T program are

1. review proposed RD&T work program and provide comments for consideration by the ARIB Manager and the Director of DTD, and
2. develop an annual SP&R work program with the RD&T work program as an integral part.

8.12. Chief Engineer

Functions of the Chief Engineer as related to the RD&T Program are:

1. participate in the development of the research strategic direction,
2. review the RIC recommendations,
3. provide general oversight regarding the implementation of research findings that are the responsibility of the Chief Engineer,
4. the Chief Engineer is available to support the implementation of research when it involves a major change or is perceived as high-risk, and
5. the Chief Engineer's Meeting can also be used to announce the availability of new design or construction options developed through research.

9. RD&T PROGRAM OVERVIEW

The purpose of the RD&T program is to conduct research that has a direct application to planning, design, construction, maintenance, safety, environment, public transportation, and intermodal transportation systems or operations at CDOT. The RD&T program also facilitates the implementation of research through knowledge sharing, specification changes, and changes in practice.

Research projects are selected annually through a process that insures that broad-based, priority issues are addressed. Research problem statements are solicited and the oversight teams review these problem statements and make recommendations to the RIC. The RIC then makes prioritized recommendations for funding based on the strategic direction. Experimental feature evaluations are not subject to this process and are funded throughout the year. These requests from the staff and Region offices are approved for funding by the ARIB Manager.

DTD Management will use the research study priority list together with the ongoing RD&T activity funding needs to develop a RD&T annual work program. In addition to funds for professional services for projects identified in the RIC priority list, appropriate funding for the following is also considered:

- experimental features on construction projects,
- pooled fund projects,
- local technical assistance program (LTAP),
- NCHRP contribution,
- TRB membership, and
- non-expendable equipment.

9.1. Experimental Features on Construction Projects

In accordance with Procedural Directive 3.1, all experimental features incorporated into federal-aid projects will be evaluated. The following steps will be followed in developing evaluation plans for experimental features:

1. The evaluation of an experimental feature will need to be requested in writing by staff or by the region.
2. Upon the receipt of a written request, the ARIB Manager will assign a study manager from the ARIB to develop a study plan.
3. Funding for labor and materials to incorporate an experimental feature into a project is normally provided by the construction project account. Evaluations during construction are normally funded with SP&R research program funds.

9.2. Pooled Fund Projects

When widespread, regional, or national interest is demonstrated for a significant problem, research studies of major importance may be conducted on a cooperative basis by several states, the FHWA, and third parties (contractors, universities, etc.). These studies may be conducted using SP&R funds without state matched funds, if approved by the FHWA administrator.

The lead agency (typically FHWA, TRB, or a state DOT) is the organization that conducts or contracts for the research and performs the administrative functions for a pooled fund study. Generally, the lead agency takes the initiative in developing the problem statement, soliciting for interest from other agencies, and obtaining FHWA approval of the study.

Participating agencies provide technical and financial assistance to the study. Depending upon the structure established by the lead agency, participating agencies may be offered a chance to provide input into the development of the scope of work and selection of the researcher. At least one agency must commit to participate in order for a project to be considered a pooled fund study.

Research teams are the groups conducting the actual scope of work.

Generally, a lead state will act as the contracting agency for all of the participants. On some occasions, FHWA or TRB will also act as the contracting agency. An advisory committee composed of representatives of each participating state and FHWA will be established to provide overall project direction and permit consideration of the cooperating states' views. FHWA or TRB management is also an option.

Requests for CDOT to participate in pooled-fund studies are received throughout the year from other states and FHWA. The following process will be used to determine participation by CDOT:

1. A RIC member sponsor will be required for each pooled-fund study.
2. ARIB staff will track the pooled-fund study performance and benefits.
3. Pooled-fund solicitations will be sorted into Type A, B, or C. *
4. Decisions will be withheld on Type B and C studies until the annual priority setting meeting.
5. CDOT will consider using set-aside funds to join type A studies early enough to enable participation in the project scoping and PI selection (with a small dollar commitment). The decision to participate will be based on whether or not the pooled-fund study is of a higher priority than the highest priority unfunded research study.
6. Type A studies will be considered for additional funding at the next annual meeting through the normal problem-statement prioritization process.
7. Each pooled-fund study will be assigned a study number and a short title. (See Appendix H.)

***Type A, B, and C definitions**

- type A - general SOW with final scope and PI selection pending,
- type B - SOW and PI predetermined, and
- type C - general subject area for research is known but specific studies will be identified by state representatives.

When multiple parties are interested in solving transportation-related problems, they may be jointly funded by several federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms as a pooled fund study. These can be related to research, planning, and technology transfer activities. There are three categories of participants in pooled fund studies: lead agency, participating agencies, and research teams.

9.3. Local Technical Assistance Program (LTAP)

LTAP is a statewide transportation training program for local governments across Colorado. The Colorado LTAP Center has been operational since 1986, and has been located at the University of Colorado, Boulder (CU) since 1998. It is a cooperative effort between the FHWA, CDOT, and CU.

LTAP was established in 1981 as the Rural Technical Assistance Program (RTAP). It is the primary way that the FHWA helps local transportation agencies learn about maintaining and improving their roads, innovative methods and materials, and ways to work smarter.

LTAP strives to bridge the gap between research and practice by conducting training sessions and demonstrations and by serving as a clearinghouse for information related to state-of-the-art technology in the construction and maintenance of roads and bridges.

9.3.1 Services

Colorado LTAP manages three training programs offering over 70 courses a year: Roads Scholar I, Roads Scholar II, and Supervisory Skills and Development Program;

The **Roads Scholar I** program started in 1991, and is designed to provide participants with the training necessary to increase their knowledge of transportation safety, local road maintenance and construction procedures, and improve their technical skills by attending a wide variety of programs available at reasonable costs.

The **Roads Scholar II: Road Master** is the second and highest achievement level in Colorado LTAP's Roads Scholar training program. The Roads Scholar II: Road Master program is an advanced training program geared towards the experienced maintenance worker, equipment operator, and manager. It is an opportunity for training at a more complex level than Roads Scholar I provides. The program includes a series of courses in four focus areas: safety, environment, transportation management, and technical skills. It is designed to provide Colorado's municipal

highway personnel in all departments with a knowledge of modern road maintenance management procedures and techniques.

The **Supervisory Skills and Development Program (SSDP)** started in the fall of 2001. Unlike the Roads Scholar Programs, SSDP is designed to help educate, prepare, and provide public works employees with the background necessary to comfortably and confidently perform in a supervisory position. The courses chosen are intended to provide a fundamental understanding of the roles and responsibilities of a supervisor and to develop tools for succeeding in management.

9.3.2 Technical Material

Colorado LTAP maintains a comprehensive, in-house lending library of instructional videos, publications, and resources focusing on transportation design, maintenance, safety, and workforce related topics. Currently there are over 2500 different publications in the Colorado LTAP library. All media and publications in the lending library are available to local agencies free-of-charge for at least a two-week period, and can be ordered online through the our website or by calling the office. Colorado LTAP staff can also provide assistance in obtaining additional transportation-related materials of special request from other libraries and databases nationally. Their library database search is available at: <http://ltap.colorado.edu/ltaplibrary/>

9.3.3 Program Funding

The LTAP program is funded nationally by the FHWA. Total funding varies from year to year, depending on the FHWA's allocation. Following is the current funding mechanism for the program:

1. FHWA contributes 50%,
2. CDOT contributes 25% using SP&R funds, and
3. CU (University of Colorado Boulder) and local registration fees contribute 25%.

9.4. National Cooperative Highway Research Program (NCHRP)

NCHRP is an AASHTO pooled-fund research program where states and the FHWA pool their funds together to address transportation research of national interest. Each state participates by contributing 5.5% of their SP&R funds. No state match is required.

Managed by TRB, the program begins by soliciting for problem statements from state transportation agencies and the FHWA. Due in September, the problem statements are reviewed by subject matter experts from TRB, FHWA, and AASHTO committees. All reviews, responses and problem statements are submitted back to state transportation agencies for balloting in January.

Based on this balloting the AASHTO Standing Committee on Research meets in March to establish the annual program of projects.

The ARIB Manager encourages problem statement submission, prepares the CDOT ballot based on input from CDOT experts and nominates CDOT staff to serve on the study panels.

Based upon these recommendations and available funding, the Research Branch Manager will prepare an annual RD&T work program and the director of DTD will submit it, as part the overall annual SP&R Work Program to the FHWA. Any major changes will need to be submitted to the FHWA for approval, otherwise an informational copy of the updated work program will be provided to the FHWA quarterly or upon request.

9.5. Transportation Research Board (TRB)

TRB is one of six major divisions of the National Research Council— a private, nonprofit institution that is the principal operating agency of the National Academies in providing services to the government, the public, and the scientific and engineering communities. The National Research Council is jointly administered by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. TRB’s varied activities—described below—annually engage more than 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest by participating on TRB committees, panels, and task forces. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

TRB was established in 1920 as the National Advisory Board on Highway Research to provide a mechanism for the exchange of information and research results about highway technology. Renamed the Highway Research Board (HRB) in 1925, the organization accomplished its mission through standing committees, publications, and an annual meeting. In the decades that followed, HRB steadily increased in size. Information exchange remained its sole mission until the 1950s, when it began to undertake management of ad hoc research projects. The first continuing research management activity—the NCHRP— started in 1962. During the 1960s, the Board’s activities became increasingly multimodal in outlook. In 1974 the HRB became the TRB. Since then, TRB’s portfolio of services has expanded significantly—first in the early 1980s, when it began conducting studies of national transportation policy issues, and again in the 1990s, when Congress, the U.S. Department of Transportation, and the state departments of transportation asked TRB to undertake additional tasks, including management responsibilities for the Transit Cooperative Research Program, guidance of ongoing research programs such as the Long-Term Pavement Performance (LTPP) studies, and management of the Innovations Deserving Exploratory Analysis (IDEA) programs. More recent additions have included new cooperative research programs in airports,

freight, and hazardous materials transportation, and the second Strategic Highway Research Program (SHRP2).

The mission of the TRB is to promote innovation and progress in transportation through research. In an objective and interdisciplinary setting, TRB facilitates the sharing of information on transportation practice and policy by researchers and practitioners; stimulates research and offers research management services that promote technical excellence; provides expert advice on transportation policy and programs; and disseminates research results broadly and encourages their implementation.

9.6. Non-Expendable Equipment

Non-expendable equipment is equipment having a useful life of more than one year and an acquisition cost of \$5,000 or more per unit. The cost of non-expendable equipment will be managed in such a manner that only those equipment costs reasonably attributable to the SP&R RD&T program are charged to it.

- Purchase of non-expendable equipment with federal funds greater than \$5,000 must be approved by FHWA.
- Inventory records for each piece of non-expendable equipment purchased or built under the RD&T program, including equipment acquired by a contractor with research funding, will be incorporated into the CDOT inventory system.
- When non-expendable property is acquired with research funds the equipment title shall rest with CDOT unless the funding source specifies otherwise.
- Non-expendable equipment costing over \$5,000 purchased with SP&R RD&T funds which has no further use in the CDOT RD&T program shall be properly disposed of and the residual value credited to the SP&R RD&T work program.

10. RESEARCH STUDY IDENTIFICATION AND DEVELOPMENT SCHEDULE

Research studies are generally started through the solicitation of problem statements. Evaluations of experimental features on construction projects are started by formal written requests from the corresponding region office and staff. Other studies funded through FHWA work orders may be proposed and requested by the ARIB Manager based on interest from CDOT personnel or FHWA personnel.

Two key processes are involved in a research project life cycle, problem statement review, which occurs prior to the RIC approval process; and research project management, which occurs after the RIC approval process (Refer to Figure 4). The steps included in these processes are as follows (dates are approximate):

10.1. Problem Statement Review and Project Selection Steps

1. CDOT Fiscal Year starts July 1. Research problem statements are solicited in July. Note however, that research staff will accept research ideas/problem statements throughout the year. (See Appendix E, "Problem Statement Form.")
2. The deadline for submitting problem statements for consideration is determined annually by the ARIB Manager, and is typically in September. After receipt of a problem statement, a preliminary literature search for other completed or ongoing research related to the problem will be performed by the research staff librarian using the TRB TRIS system. If the search results do not provide a solution for the problem, the submitter of the problem statement will be asked to develop a complete problem statement.
3. Oversight teams (OTs) will complete analysis of each problem statement (previous research, TRIS search results, feasibility, and application) prior to the RIC meeting. Only problem statements that are not currently being studied, either by CDOT or another agency, will be considered. The OT will then develop a prioritized list of the accepted problem statements for presentation to the RIC. The OT manager will assign a study number to each problem statement (Appendix H).
4. With the approval of the appropriate RIC member/sponsor, OTs will submit recommendations to the RIC by the end of February. Recommendations will include research to address the strategic direction of CDOT, only.
5. The RIC will meet and prioritize the recommended problem statements by March 30.
6. Recommended problem statements will be finalized by the Chief Engineer, the Director of the Division of Transportation Development, and the ARIB Manager by April 30.
7. Approved problem statements are announced to Colorado public universities.
8. The study manager organizes a study panel for each new research study in June and July. Research staff and the study panel start developing the final scopes of work and RFP's for the recommended research studies.

- Pending incorporation of projects in the work program and subsequent approval, funding becomes available on July 1.

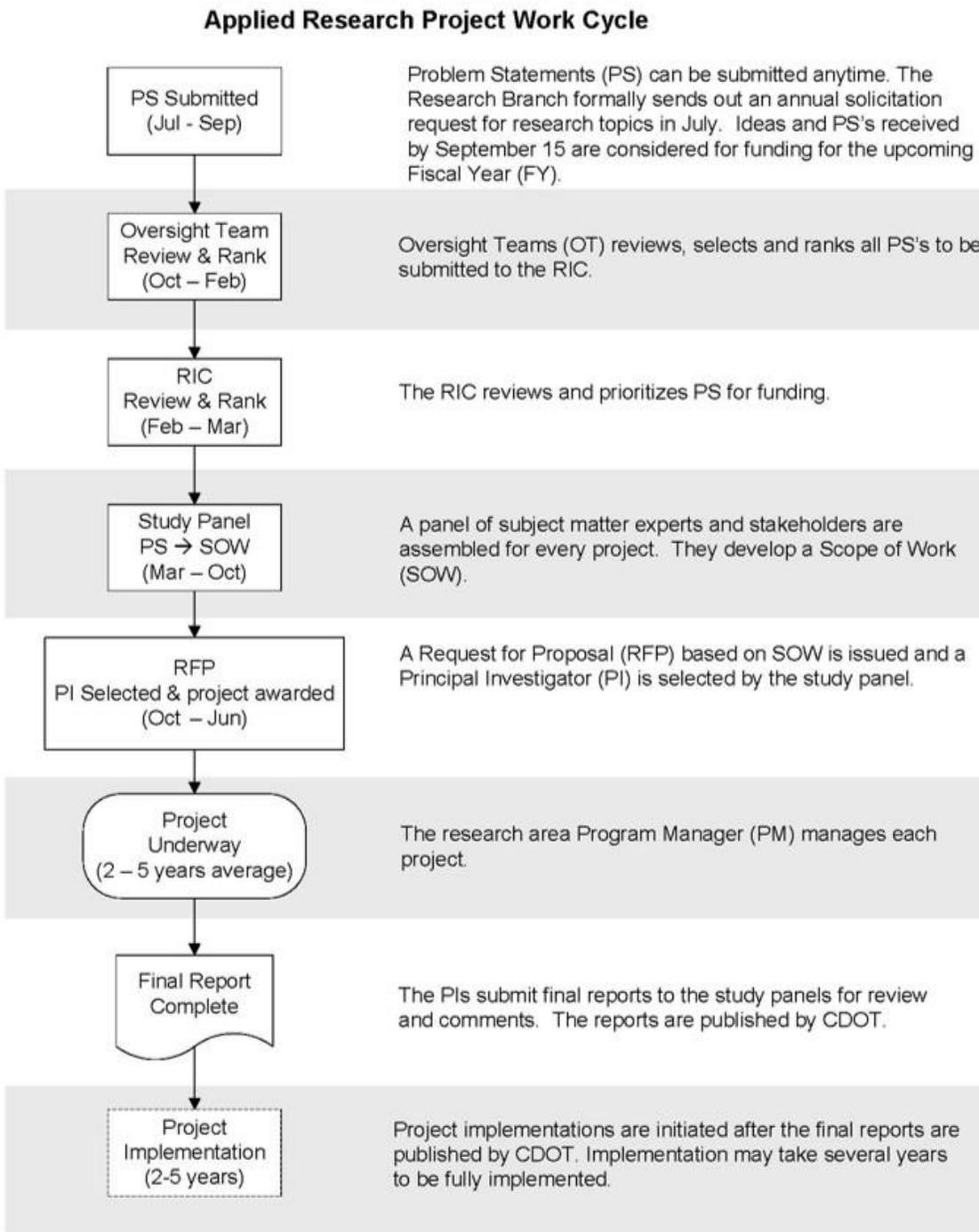


Figure 4 - Project Work Cycle

10.2. Research Project Management Steps

Once projects are identified by the RIC and budgeted, ARIB staff develops the problem statements into research projects. Using panels of subject matter experts and stakeholders, a SOW is developed and an RFP is sent to potential researchers. The best qualified proposer is hired to conduct the research. A research project is rarely completed within the same fiscal year it is budgeted. Studies involving the evaluation of the performance of features constructed as part of Colorado highways may take many years to complete. The research program consists of new studies budgeted in the current fiscal year and ongoing studies that are carried over from previous fiscal years.

The following are key steps that are undertaken in conducting a research project:

Assign a Study Manager

Once an experimental feature or a problem statement has been identified as a research project the Manager of ARIB will assign a study manager from the Research staff or a subject matter expert from within the department as appropriate.

It is expected that the study manager will stay involved with the research project and related issues through literature reviews, discussions with other knowledgeable people on the subject, and consultation with the PI and problem statement author.

Establish RIC Sponsorship

A RIC member will be assigned to sponsor the study. The study manager will consult with the RIC sponsor throughout the study. At a minimum the RIC sponsor will approve the study panel membership, the RFP, the PI, the final report, and the implementation plan.

Assemble a Study Panel

With input from the RIC sponsor, the study manager will assemble a study panel composed of at least two people from CDOT who are outside the Research Branch and have an interest in the problem. One of the members of the panel should be the appropriate departmental subject matter expert. This person, or another primary panel member will be the Study Panel Leader. If no study panel leader is identified, the RIC sponsor will assign one. FHWA participation will also be solicited. Study Panel members and the Study Manager will develop a SOW based on the problem statement. (See also Functions of the Study Panel in Who's Who in Research)

Initiate RFP or Procurement Process

If university proposals are sought, the ARIB Manager will advertise the RFP to relevant universities based on the SOW, and the Study Panel will review proposals received to select the PI. If these proposals are insufficient, or none are received, the study manager will advertise the

project through the CDOT procurement process, and the study panel will assist in selection of a PI through this process.

Negotiate the PI Contract

The study manager will negotiate or review the final agreement with the PI. This agreement will require

- submitting progress reports to the study manager in a timely manner, quarterly or semiannually (according to the discretion of the project manager), using CDOT format;
- providing the final report in both electronic form and a black and white reproducible hard copy in the CDOT report format;
- providing a concise, one-page executive summary of the final research report including a brief recommendation of implementation; and
- submitting a recommendation for implementation.

Contract Processing

The study manager should do the appropriate follow-up with the procurement agent to insure that the agreements get processed in a timely manner. Contracts and task orders must require a final report in the "Research Report Format," (see Appendix C.)

Contract Start

Once the proposal is approved and the necessary contract signatures are acquired, the study manager will issue a notice to proceed to the PI. The PI will proceed with the study as outlined in the proposal, generally beginning with a study panel kick off meeting.

Progress Reports

Progress reports are required of each study semiannually or quarterly, as appropriate. The study managers will follow-up with PIs to insure the timely submission of these reports in CDOT format. (See Appendix C "Research Report Format.")

- The study manager will collect the progress reports and upload them to appropriate subject area folder and inform the Staff Librarian when all their project progress reports have been updated. The name of the progress report files will be:
 - "StdY###-## YYYYMM," where ###-## is the study number with leading zeros if needed (refer to Appendix H), followed by the appropriate year and month of the progress report.
- The ARIB Staff Librarian will use these progress reports to update the TRB Research-In-Progress database.
- The study manager will review the progress reports and consult with the ARIB Manager or when appropriate, the study panel members, and the PI if the study appears to be behind schedule or not following in the direction dictated by the study proposal.

- Progress reports will be spell checked, will include the correct dates for the reporting period, and will be not more than 2 pages long. Detailed information that exceeds this limit will be kept in the project file.
- The Staff Librarian will post the progress reports on the ARIB web site and notify the study managers, the DTD Director, the ARIB Manager, and the Colorado Division of FHWA of the update. The study manager will be responsible for informing study stakeholders of progress report availability on the web.

Tracking the Study

The study manager will use progress reports and other information to monitor the progress of the study and determine if the PI is following the scope of work and is within the budget. The study manager will work with the PI to correct and/or clarify any deficiencies informing the study panel and the ARIB Manager of any problems.

Payments

The study manager will approve invoices for payment that are consistent with the progress reported.

Changes to the Study

If changes in the schedule, budget, or work plan are deemed necessary, it is the responsibility of the PI to submit an amendment in writing to the study manager following the time frame and conditions for the changes as directed by the contract. A minimum of one month shall be allowed when requesting an amendment to an agreement.

The following steps may be involved in making changes to a study:

- The study manager should consult with the study panel members about any changes to the study. The study manager need not get approval from each panel member but should consult with each member before approving or disapproving.
- Approval of the change from the ARIB Manager is mandatory.
- The custodian of the task orders must be notified of any amendments to an agreement.
- Subsequent to the ARIB Manager's approval, the study manager should initiate the change in SAP and work with the DTD Business Office and Procurement as necessary.
- Changes to non-SP&R, or non-state-funded research, must follow the approval process of the funding source.

Final Report Review

The PI shall submit a draft final report two months before the end of the project. The study panel members are responsible for reviewing the final report. The study manager may also request that other subject matter experts, from both inside and outside the department, review the report. This review should address the technical merits of the reports, as well as editorial review including

spelling and grammar. All comments from the reviewers need to be addressed by the study manager and the PI prior to the publishing of the report.

Presentation of the Research to the Study Panel and Interested Parties

The PI will present the finding and recommendations of the research through a PowerPoint presentation to the study panel members and other interested parties who are invited by the project manager. The PI will incorporate all comments and suggestion received during the presentation into the final report.

After the PI has addressed all comments and has completed another editorial and consistency review, the revised report will be given to the Staff Librarian for a final review. The Staff Librarian will review the cover, the front matter, the executive summary, and conclusions for grammatical and spelling errors and conformance to established guidelines.

Final Report

Final reports should be prepared in a timely manner for each research project and must follow the "Research Report Format" (Appendix C). A completed "Technical Report Documentation Page" must also be included in the report (Appendix D). Conclusions should be well justified by corresponding data, and research findings by others should be referenced appropriately.

The PI should submit an electronic Microsoft Word file of the final report to the study manager. The report will be converted to PDF and put on the Research web site.

Copyright Authorization

Any author will be free to copyright material developed under the contract with the provision that CDOT and FHWA (if the research is funded by federal-aid) reserve a royalty-free, non-exclusive, and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use the work for government purposes (see also Appendix G).

11. IMPLEMENTATION OF RESEARCH

Implementation of research findings is an essential element of the research process and each research project has a dynamic implementation plan (Appendix J). An Implementation Plan is required for each research problem statement that is submitted to the RIC. For approved projects, the plan is revised and expanded throughout the study as the specifics and findings of the study evolve. Although somewhat speculative at first, the plan identifies the expected implementation product, the steps needed to put the findings into standard practice at CDOT, and who in the department will be responsible for each of these steps. These steps typically include an effort to communicate the findings to appropriate staff (presentation or training), pilot projects, approvals, and incorporating the findings into CDOT operating documents (Standard Specifications, Design Manual, Materials Manual, etc.).

RIC members review and approve projects for funding. They also should support the research projects throughout the research process, including implementation. Generally, the RIC sponsor or the project champion will be responsible for the implementation phase, which follows the completion of the final report, and may last several years. This phase may include modification of a CDOT practice or specification; tracking of any costs or benefits resulting from implementation of the results; or identifying barriers that prevent the implementation; etc. In some cases, such as innovative research projects that result in negative results, no implementation will be appropriate.

The research program coordinates activities including technology transfer and implementation by meeting with study managers and PIs, reviewing implementation plans, assisting on implementation projects, and tracking implementation plan progress. Research implementation is also tracked annually as one of ARIB's measures of performance (Stewardship Agreement, Section 13).

12. PEER EXCHANGE PROCESS

Quality in any process is not a static, one-time accomplishment; but a striving for continuous improvement. Such continuous improvement must be accomplished by a periodic review of the practices. One technique designed to improve the quality of the program is a Peer Exchange examination of the deliverables of the research program through the management process.

Peer Exchange Panel

A panel with knowledge of state research programs will be utilized to examine the RD&T management process and identify areas for potential improvement. A comprehensive review of the research management process entails at least a 2-3 day agenda, and will be conducted at least once every five years by a team external to CDOT. The team may include the following:

- research managers from other state DOTs
- representatives from the FHWA
- representatives from other federal, state, regional, or local transportation agencies
- representatives with research management responsibilities from private consulting companies, government laboratories, or universities

The Peer Exchange discussion items may include the following:

- discussion, with the RIC and other research staff, of the research program's management system as described in this manual
- discussion, with executive management, of the strategic plan for research and its relationship to the strategic plan for the department
- discussion of the scope of the research program, including all the activities in the work program
- review of example projects as they advance through the system, including the solicitation, selection, choice of principal investigator, project progress, and technology transfer activities
- discussion with suppliers and customers of the RD&T program, which may include any of the following: RIC members, OT members, study panel members, CDOT researchers, past or ongoing research contractors, and CDOT planning, design, maintenance, or operations personnel

Peer Exchange Panel Report

The review team will prepare a draft report that addresses the efficiency and effectiveness of the management process in meeting the RD&T program's overall mission. Issues such as

- the ability to recognize and respond to future research needs,
- the ability to focus on priority issues,
- timeliness,
- objectivity,
- appropriateness and accuracy of documentation,
- impartiality,
- training of staff,
- technology transfer effectiveness,
- incorporation of results into standard plans, and
- comparison to other similar programs.

After discussing their findings and recommendations with CDOT staff, the reviewers will finalize the report and submit it to the FHWA. CDOT may accept the panel's reporting as it would any other report that is designed to improve management processes.

Participation in Reviews with other state DOTs

CDOT research staff will participate in reviews of other state DOT research programs provided travel expenses are paid by others. This should be a valuable experience to those who act as reviewers, bringing back new ideas, insights, and new perspectives to the Colorado program.

13. STEWARDSHIP AGREEMENT

The purpose of the Stewardship and Oversight Agreement is to formalize the roles and responsibilities of FHWA, Colorado Division and CDOT for administering the Federal-Aid Highway Program (FAHP). It is developed in partnership with FHWA's Colorado Division and CDOT (refer to Appendix K).

Appendices

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APPENDIX A – CDOT RESEARCH BRANCH HISTORY

1962

- U. S. Congress passed highway legislation which included a required 1.5% of Federal highway fund to be set-aside for planning and research. The Colorado Department of Highways used these funds for various studies and planning activities, but it was not until a few years later that any actual research was funded.

1965

- The Research and Special Studies Section was established within the Planning and Research Division of CDOT.

1966

- The Section got its first major research project by working cooperatively with the Asphalt Institute to evaluate the Ordway, Colorado Experimental Base Project. Shortly thereafter, additional roadway research projects were added with staff focusing on detailed evaluation of the roadway condition for the control and test sections.

1970

- With the acquisition of a locked-wheel skid system, the section started conducting an annual “Sufficiency Study” reporting condition of the 9,000 miles of state highways. Data included skid resistance, roadway smoothness, and a windshield survey of cracking and rutting.

1972

- In order to meet the requirement of the 1970 Clean Air Act, the section began a noise monitoring and modeling project and developed the program to implement it in the districts, with Richard Griffin leading the effort.

1973

- The Section’s first departure from research that evaluated roadway experimental features was a study on high-altitude vehicle emissions to support the design of the Eisenhower Tunnel which, at 11,000 feet, was to become the highest power-ventilated tunnel in the world.

1974

- Mark Safford took over the section as BB Gerhardt retired.

1975

- The Noise program developed by the section staff moved to district.
- The section began conducting air quality monitoring and modeling for construction projects to meet requirements of the 1970 Clean Air Act, with Robert LaForce leading the monitoring effort and

Richard Griffin leading the modeling effort. Later Keith Burrows was hired to lead the entire air quality program.

1977

- Denis Donnelly took over the section as Mark Safford was moved to run the traffic monitoring and analysis program for the division.

1979

- The Technology Transfer program was established in the section lead by Lowell B. Steere, later by Rebecca Spain, and then by Beth Moore as the CDOT library was folded into it.

1980

- The Air Quality program developed by section staff moved to Environmental Branch.

1986

- The section made Colorado the 39th state to establish a Local Technical Assistance Program (LTAP). The Transportation Information Center, as it was originally called, began serving local Colorado agencies in 1986 as a cooperative effort between the FHWA, CDOT, and Colorado State University. The program provides low-cost training and technical assistance to local road and bridge agencies.

1988

- The Strategic Highway Research Program (SHRP) was established by Congress. Colorado's involvement was coordinated by Denis Donnelly.
- The section became the Research and Development Branch.
- Steven Horton was hired to work in the branch to establish and develop CDOT's Pavement Management System (PMS).

1990

- Denis Donnelly was placed on special assignment for one year to work directly for the SHRP program in Washington, D.C. and Richard Griffin became the Acting Research Coordination Engineer.
- CDOT became the second state in the country to be approved by FHWA to operate under the Research Management Option where only very large projects required FHWA approval.
- After its initial development in the Branch, the PMS program moved to Materials Laboratory.

1991

- Through Colorado legislation the Colorado Department of Highways became the Colorado Department of Transportation (CDOT).

- Based on a federal initiative, the Intelligent Vehicle Highway System (IVHS) was established and developed within the branch.
- Denis Donnelly, shortly after returning from his special assignment in Washington, D.C., was promoted to Materials Engineer and left Richard Griffin again as the Acting Research Coordination Engineer.

1992

- With Ralph Trapani (Manager of the Glenwood Canyon Project) as the Director, the Colorado Transportation Institute (CTI) was established with the branch providing primary support.

1993

- Congressional action required that 25% of the State Planning and Research funds be set aside for research.

1994

- The IVHS research staff and responsibilities were transferred to new Intelligent Transportation System (ITS) Branch under the Chief Engineer.

1995

- The research program was re-engineered by expanding the use of technical expertise for identifying research needs, broadening the scope of the program, and raising the level of membership of the Research Council.
- The Traffic Monitoring and Analysis Section was placed within the branch.

1996

- Even with many accomplishments, including 2 patents, CDOT funding priorities changed and CTI was dissolved.

1998

- Division of Transportation Development re-organization moved the Traffic Monitoring and Analysis Section and the branch became dedicated solely to research.
- The University of Colorado at Boulder replaced Colorado State University as the implementing contractor for the Colorado Local Technical Assistance Program (LTAP). LTAP is funded nationally by the FHWA, which requires a 50/50 financial match. CDOT supplies 25% of the match from SP&R funds and the University of Colorado provides the other 25%.

1999

- With research as its sole role, the branch continued to expanding the focus: from just pavement research in the earlier years to hydraulics, structures, traffic and safety, environmental and alternative transportation modes.

2006

- The Research Coordination Engineer, Richard Griffin, retired. Jake Kononov, Region 6 Traffic Engineer, became the Research Director and because of his background moved the branch toward more traffic and highway safety research and renamed Research Branch to the Applied Research and Innovations Branch (ARIB).

2012

- Jake Kononov retired and Roberto DeDios (Pavement Research Manager) became the Acting Director of ARIB.

2013

- Roberto DeDios retired. Dr. Aziz Khan (Structure, Hydraulic and Geotechnical Research Manager) became the Acting Director of ARIB.
- Amanullah Mommandi became the Director of ARIB after many years as CDOT Hydraulic Program Manager.

APPENDIX B – QUICK STUDY PROGRAM

The Quick Study program was established to provide fast response to CDOT issues related to the implementation of new technologies. A quick study may be a "paper study" where ARIB personnel review research reports in a specific area and prepare recommendations for engineering, construction, maintenance, or planning personnel. A quick study may also be an evaluation of a new material, method, or product, which represents a significant change over standard practice.

All quick studies will culminate in a one-page summary similar to that in the Appendix I, "CDOT Research Implementation Plan Form" and Appendix J, "Implementation Plan Instructions". Other documentation, such as field notes, review notes, or a bibliography, may also be developed and kept on file unless the quick study results in a formal report. Summary sheets will be kept in a notebook at the library and logged into the library database.

- Quick studies results will be sent by the study manager to all region offices.
- The ARIB Manager will maintain a list of quick studies and the progress on each will be reported on the semi-annual progress report for quick studies.
- A quick study will normally last less than 12 months. Literature reviews and construction evaluations are expected to take much less time. Progress reports should be prepared and submitted on Quick studies that have not been completed by the due date of the semi-annual progress reports.
- Quick studies active during the annual program development process and expecting to be ongoing into the next program year, will be incorporated into the technical research oversight team recommendations.

APPENDIX C – RESEARCH REPORT FORMAT

On completion of the study, the PI will provide the report in the form of a Microsoft Word file to the ARIB. The librarian will review the word document, convert it to PDF format, and post it online. Reports are published exclusively in electronic format.

Format and Content:

Spacing

- 1 1/2 spaces between lines and after headings, and
- triple space between paragraphs.

Fonts

- use Times New Roman font, size 12 for text, size 14 for headings.

Pagination

- use lower-case Roman numerals for front matter;
- use stand-alone Arabic numbers for body of report (no italics or dashes);
- number pages of appendices A-1, B-1, etc.; and
- center page numbers 0.5 inches up from the bottom edge of the page.

Chapters

- insert 1 1/2 spaces between headings and text - do not underscore headings or use horizontal lines;
- left-justify chapter headings and headings for front matter, all capital letters, bold type, one inch from top of page;
- left-justify second-level headings, initial capitals, bold type; and
- left-justify third-level headings, initial capitals, italics - do not bold (place on first line of paragraph).

Tables and Figures

- number figures consecutively and label with unique captions centered at the bottom, bold type (note: they should be called figures, not photos);

Figure 1. This is how the captions should look.

- number tables alphabetically and label with unique captions centered at the top, bold;
- place figures and tables as close as practical to textual references;
- place graphics so that they can be viewed without turning the page sideways (if a graphic must be placed sideways, the top should be on the left side of the page); and
- tables should supplement, not duplicate, the text.

Abbreviations, Acronyms and Symbols

- define the first time they are used, and
- include list of acronyms if warranted.

Numbers

- spell out numbers from one through nine;
- use numerals for numbers 10 and above, unless they are the first word of a sentence;
- If a number 10 or above is in the same sentence as a lower number, use all numerals; and
- use numerals for units of money, measurement, and time.

Widows and orphans

- avoid leaving a single line of text at the top or bottom of a page; and

- do not leave a header without text at the bottom of a page.

Disclaimer (use template)

- place on inside of front cover.

Technical Report Documentation Page (use template)

- use font size 10;
- type report title in all caps;
- report title should be an exact match of title on report cover;
- key words to facilitate a search will be entered in the appropriate box;
- supplement, do not duplicate, words from the title;
- do not capitalize unless they are proper nouns;
- type in continuous line with commas separating key words;
- include front matter in the page count; and
- Number documentation page as page i.

Acknowledgements

- include list of study panel members on all reports.

Executive Summary

- place after acknowledgements page,
- approximately one-two pages long,
- discuss why research was needed,
- discuss how research was completed,
- compare actual research results with expectations,
- discuss how the research can be used by CDOT,
- include recommendations for action or further research, and
- outline cost benefits.

Implementation Statement

- a subheading under Executive Summary (on same page);
- identify recommendations to be implemented at CDOT;
- include one or two paragraphs with a specific CDOT implementation strategy; and
- Discuss who could benefit from this research.

Table of Contents:

- place after executive summary;
- do not include front matter in table of contents;
- consecutively number chapters and break down into numbered sections;
- number appendices A, B, etc.;
- wording and punctuation should exactly match headings in report; and
- include List of Figures and List of Tables

Introduction:

- include background, study objectives and scope of study.

Conclusion and Recommendations

- conclusions and recommendations should be separate sections of chapter;
- both conclusions and recommendations should be valid, appropriate, and properly supported; and
- discuss how research findings should be used.

References

- give credit for all information taken from other sources; and
- include author, title, volume and issue or report number, page number, publisher or issuing agency, publication date.

Example

Scheinberg, Phyllis. "Prospects for Innovation Through Research, Intelligent Transportation Systems, State Infrastructure Banks, and Design-Build Contracting." GAO/T-RCED-97-83. General Accounting Office, March 6, 1997.

- To cite files from the internet, provide the following information
 - author's name (if known),
 - full title of the document in quotation marks,
 - title of the complete work if applicable in italics,
 - date of publication or last revision (if available),
 - full http address (URL) enclosed within angle brackets, and
 - date the source was accessed in parentheses.

Example:

Burka, Lauren P. "A Hypertext History of Multi-User Dimensions." *MUD History*, 1993. <<http://www.ccs.neu.edu/home/1pb/mud-history.html>> (5 Dec. 1994).

Report Preparation Checklist

- make sure title, report # and date are the same on cover and documentation page;
- make sure keywords are included in documentation page;
- make sure font sizes and types are consistent;
- have all members of study panel review report;
- have at least one person review entire report for clarity and grammar; and
- spell check report after all editorial changes have been made

APPENDIX D – RESEARCH REPORT TECHNICAL REPORT DOCUMENTATION PAGE

Technical Report Documentation Page

1. Report No. CDOT-YYYY-##		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle				5. Report Date	
				6. Performing Organization Code	
7. Author(s)				8. Performing Organization Report No. CDOT	
9. Performing Organization Name and Address				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address Colorado Department of Transportation - Research 4201 E. Arkansas Ave. Denver, CO 80222				13. Type of Report and Period Covered	
				14. Sponsoring Agency Code	
15. Supplementary Notes Prepared in cooperation with the US Department of Transportation, Federal Highway Administration					
16. Abstract Implementation:					
17. Keywords			18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service Springfield, VA 22161; www.ntis.gov		
19. Security Classif. (of this report) unclassified		20. Security Classif. (of this page) unclassified		21. No. of Pages	22. Price

Instructions for technical documentation page

It is the intent of this form that all information should fit on a single page. Pay careful attention to the Abstract (cell 16) and craft it appropriately short to maintain one page length.

Note: Unless otherwise directed in these instructions, cells should be left blank.

- Cell 1 for PIs, leave blank. This number will be determined by the CDOT Librarian or Project Manager.
This number is based on the order of publication to the CDOT website each year. Enter CDOT-yyyy-##. Use leading zeros for numbers 1-9.
For example the first report published to the CDOT Research Branch website in 2015 was Report No “CDOT 2015-01”
- Cell 4 enter exact title of report in capital letters
- Cell 5 enter month and year of report (no comma)
- Cell 7 enter author(s) names separated by commas.
- Cell 8 repeat CDOT report number. This space is also available for university/consultant to put in their own number
- Cell 9 enter name and address of performing organization.
- Cell 11 Enter study/file number
- Cell 13 Enter “final”, “interim”, or “construction” as appropriate.
- Cell 16 Provide a brief abstract of the report, including research method, findings, and conclusions. Describe implementation recommendations in a separate paragraph under the abstract. Keep the TOTAL form length to one single page (see above).
- Cell 17 Enter keywords or phrases that are not part of the title. Use lower case (except for proper nouns and acronyms). Separate with commas. Do not end with a period.
- Cells 19-20 Security Classification is “unclassified” unless otherwise directed.
- Cell 21 Calculate total # of pages including front matter and appendices
- Cell 22 Leave blank

APPENDIX E – PROBLEM STATEMENT FORM

CDOT Research Problem Statement Form

PROBLEM STATEMENT TITLE:

[Name of proposed Research Study]

AUTHOR:

Name:

Organization:

Phone:

E-mail:

Date Submitted:

SPONSOR:

[CDOT Branch/Program Manager or Research and Implementation Council (RIC) member who is supporting the Research Study]

CHAMPION:

[CDOT staff who will lead the research and have a major involvement in the study and implementation of the results. No Research Studies will be initiated without a CDOT staff champion.]

DESCRIPTION OF PROBLEM STATEMENT:

[Background and description of research idea]

PRODUCT OF RESEARCH:

[Describe the expected product of the research that can be used for planning, designing, building, maintaining or operating, and improving safety of transportation infrastructure in Colorado.]

BENEFITS OF RESEARCH:

[Describe the expected benefits of the research. When will they be realized? How can they be measured and tracked?]

ESTIMATED TIME TO COMPLETE RESEARCH:

- 6 months
- 1 year
- 2 years
- 3 years
- More than 3 years

COST FOR RESEARCH:

[Please include the itemized estimated cost. The funds for approved projects will be available July 1, next fiscal year.]

Itemized Cost Estimate:

Total Cost Estimate:

- Less than \$25,000
- \$25,000 – \$50,000
- \$50,000 – \$75,000
- \$75,000 – \$100,000
- Other, please specify.

LEVERAGE/FEDERAL FUNDS:

[Would others (states, local governments, federal, etc.) be interested in this research? Are there already funding partners, or should CDOT pursue funding partners?]

RESEARCH IMPLEMENTATION AND RECOMMENDATION:

[Describe how the research recommendations can be used in the planning, design, construction, maintenance or operation, and safety improvement of Colorado's transportation system. Identify training need and use of products.]

RESEARCH PROGRAM AREAS: [Select one or more]

- Structures, Hydraulics, Soils, and Geotechnical
Aziz.Khan@state.co.us, (303) 757-9522
- Environmental, Sustainability, and Water Quality
Bryan.Roeder@state.co.us, (303) 512-4420
- Safety, Operations, and Planning
David.Reeves@state.co.us, (303) 757-9518
- Pavements and Materials
Richard.Griffin@state.co.us, 303) 757-9972
- Additional uncategorized research topics
Amanullah.Mommandi@state.co.us, (303) 757-9044

Please send completed form to the above appropriate research program area manager(s) by e-mail. If you have any questions, please contact the above individuals.

APPENDIX F – TYPICAL RESEARCH INVITATION LETTER



COLORADO
Department of Transportation
Division of Transportation Development
Applied Research and Innovation Branch

July 21, 2015
Greetings,

The Colorado Department of Transportation (CDOT)-Division of Transportation Development- Applied Research and Innovation Branch is soliciting problem statements to develop the FY17 research program. A problem statement is a short form describing a transportation problem and/or potential innovation that is proposed for detailed study. Research ideas will be reviewed by the appropriate CDOT Research Oversight Team members and then submitted to the Research and Implementation Council (RIC) for approval and fund allocation. We appreciate your effort in submitting your problem statements to CDOT research staff by Tuesday, September 15, 2015.

Send your problem statements to the following appropriate research program area manager:

- Aziz Khan - Aziz.Khan@state.co.us, (303) 757-9522 - Structures, Hydraulics, Soils, and Geotechnical;
- Bryan Roeder - Bryan.Roeder@state.co.us, (303) 512-4420 - Environmental, Sustainability, and Water Quality;
- David Reeves - David.Reeves@state.co.us, (303) 757-9518 - Safety, Operations, and Planning;
- Richard Griffin - Richard.Griffin@state.co.us, Pavements and Materials - (303)757-9972; and
- Amanullah Mommandi - Amanullah.Mommandi@state.co.us, (303) 757-9044 - Additional uncategorized research topics and ideas.

The problem statement form is attached and available on the research branch website which can be accessed at <http://www.coloradodot.info/programs/research>.

Note that this is **NOT** a process to apply for CDOT research funds, but is undertaken to formulate a comprehensive set of transportation-related research ideas. After the research ideas are prioritized selected and funded, a CDOT study panel will develop the final scope of work, and universities and consultants will be asked to submit proposals to conduct the research. For approved projects, funds will be available July 1, 2016.

Thank you in advance for your time and effort in sharing your novel and innovative ideas with CDOT. If you have any questions related to the research program, please do not hesitate to contact us.

Sincerely,

Amanullah Mommandi, M.S., P.E.
Manager of Applied Research and Innovation Branch
CDOT - Division of Transportation Development
Tel: (303) 757-9044
E-mail: amanullah.mommandi@state.co.us

APPENDIX G – MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES FROM THE EXECUTIVE OFFICE OF THE PRESIDENT

Executive Office of the President
Office of Science and Technology Policy
Washington, D.C. 20502
February 22, 2013

MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: John P. Holdren Director

SUBJECT: Increasing Access to the Results of Federally Funded Scientific Research

1. Policy Principles

The Administration is committed to ensuring that, to the greatest extent and with the fewest constraints possible and consistent with law and the objectives set out below, the direct results of federally funded scientific research are made available to and useful for the public, industry, and the scientific community. Such results include peer-reviewed publications and digital data.

Scientific research supported by the Federal Government catalyzes innovative breakthroughs that drive our economy. The results of that research become the grist for new insights and are assets for progress in areas such as health, energy, the environment, agriculture, and national security.

Access to digital data sets resulting from federally funded research allows companies to focus resources and efforts on understanding and exploiting discoveries. For example, open weather data underpins the forecasting industry, and making genome sequences publicly available has spawned many biotechnology innovations. In addition, wider availability of peer-reviewed publications and scientific data in digital formats will create innovative economic markets for services related to curation, preservation, analysis, and visualization. Policies that mobilize these publications and data for re-use through preservation and broader public access also maximize the impact and accountability of the Federal research investment. These policies will accelerate scientific breakthroughs and innovation, promote entrepreneurship, and enhance economic growth and job creation.

The Administration also recognizes that publishers provide valuable services, including the coordination of peer review, that are essential for ensuring the high quality and integrity of many scholarly publications. It is critical that these services continue to be made available. It is also important that Federal policy not adversely affect opportunities for researchers who are not funded by the Federal Government to disseminate any analysis or results of their research.

To achieve the Administration's commitment to increase access to federally funded published research and digital scientific data, Federal agencies investing in research and development must have clear and coordinated policies for increasing such access.

2. Agency Public Access Plan

The Office of Science and Technology Policy (OSTP) hereby directs each Federal agency with over \$100 million in annual conduct of research and development expenditures to develop a plan to support increased public access to the results of research funded by the Federal Government. This includes any results published in peer-reviewed scholarly publications that are based on research that directly arises from Federal funds, as defined in relevant OMB circulars (e.g., A-21 and A-11). It is preferred that agencies work together, where appropriate, to develop these plans.

Each agency plan must be consistent with the objectives set out in this memorandum. These objectives were developed with input from the National Science and Technology Council and public consultation in compliance with the America COMPETES Reauthorization Act of 2010 (P.L. 111-358).

Further, each agency plan for both scientific publications and digital scientific data must contain the following elements:

- a) a strategy for leveraging existing archives, where appropriate, and fostering public-private partnerships with scientific journals relevant to the agency's research;
- b) a strategy for improving the public's ability to locate and access digital data resulting from federally funded scientific research;
- c) an approach for optimizing search, archival, and dissemination features that encourages innovation in accessibility and interoperability, while ensuring long-term stewardship of the results of federally funded research;
- d) a plan for notifying awardees and other federally funded scientific researchers of their obligations (e.g., through guidance, conditions of awards, and/or regulatory changes);
- e) an agency strategy for measuring and, as necessary, enforcing compliance with its plan;
- f) identification of resources within the existing agency budget to implement the plan;
- g) a timeline for implementation; and
- h) identification of any special circumstances that prevent the agency from meeting any of the objectives set out in this memorandum, in whole or in part.

Each agency shall submit its draft plan to OSTP within six months of publication of this memorandum. OSTP, in coordination with the Office of Management and Budget (OMB), will review the draft agency plans and provide guidance to facilitate the development of final plans that are consistent with the objectives of this memorandum and, where possible, compatible with the plans of other Federal agencies subject to this memorandum. In devising its final plan, each agency should use a transparent process for soliciting views from stakeholders, including federally funded researchers, universities, libraries, publishers, users of federally funded research results, and civil society groups, and take such views into account.

3. Objectives for Public Access to Scientific Publications

To the extent feasible and consistent with law; agency mission; resource constraints; U.S. national, homeland, and economic security; and the objectives listed below, the results of unclassified research that are published in peer-reviewed publications directly arising from Federal funding should be stored for long-term preservation and publicly accessible to search, retrieve, and analyze in ways that maximize the impact and accountability of the Federal research investment.

In developing their public access plans, agencies shall seek to put in place policies that enhance innovation and competitiveness by maximizing the potential to create new business opportunities and are otherwise consistent with the principles articulated in section 1.

Agency plans must also describe, to the extent feasible, procedures the agency will take to help prevent the unauthorized mass redistribution of scholarly publications.

Further, each agency plan shall:

- a) Ensure that the public can read, download, and analyze in digital form final peer-reviewed manuscripts or final published documents within a timeframe that is appropriate for each type of research conducted or sponsored by the agency. Specifically, each agency:
 - i) shall use a twelve-month post-publication embargo period as a guideline for making research

papers publicly available; however, an agency may tailor its plan as necessary to address the objectives articulated in this memorandum, as well as the challenges and public interests that are unique to each field and mission combination, and

- ii) shall also provide a mechanism for stakeholders to petition for changing the embargo period for a specific field by presenting evidence demonstrating that the plan would be inconsistent with the objectives articulated in this memorandum;
- b) Facilitate easy public search, analysis of, and access to peer-reviewed scholarly publications directly arising from research funded by the Federal Government;
- c) Ensure full public access to publications' metadata without charge upon first publication in a data format that ensures interoperability with current and future search technology. Where possible, the metadata should provide a link to the location where the full text and associated supplemental materials will be made available after the embargo period;
- d) Encourage public-private collaboration to: i) maximize the potential for interoperability between public and private platforms and creative reuse to enhance value to all stakeholders, ii) avoid unnecessary duplication of existing mechanisms, iii) maximize the impact of the Federal research investment, and
iv) otherwise assist with implementation of the agency plan;
- e) Ensure that attribution to authors, journals, and original publishers is maintained; and f) Ensure that publications and metadata are stored in an archival solution that:
 - i) provides for long-term preservation and access to the content without charge, ii) uses standards, widely available and, to the extent possible, nonproprietary archival formats for text and associated content (e.g., images, video, supporting data), iii) provides access for persons with disabilities consistent with Section 508 of the Rehabilitation Act of 1973,¹ and iv) enables integration and interoperability with other Federal public access archival solutions and other appropriate archives. Repositories could be maintained by the Federal agency funding the research, through an arrangement with other Federal agencies, or through other parties working in partnership with the agency including, but not limited to, scholarly and professional associations, publishers and libraries.

4. Objectives for Public Access to Scientific Data in Digital Formats

To the extent feasible and consistent with applicable law and policy²; agency mission; resource constraints; U.S. national, homeland, and economic security; and the objectives listed below, digitally formatted scientific data resulting from unclassified research supported wholly or in part by Federal funding should be stored and publicly accessible to search, retrieve, and analyze. For purposes of this memorandum, data is defined, consistent with OMB circular A-110, as the digital recorded factual material commonly accepted in the scientific community as necessary to validate research findings including data sets used to support scholarly publications, but does not include laboratory notebooks, preliminary analyses, drafts of scientific papers, plans for future research, peer review reports, communications with colleagues, or physical objects, such as laboratory specimens. Each agency's public access plan shall:

- a) Maximize access, by the general public and without charge, to digitally formatted scientific data created with Federal funds, while:
 - i) protecting confidentiality and personal privacy,
 - ii) recognizing proprietary interests, business confidential information, and intellectual property rights and avoiding significant negative impact on intellectual property rights, innovation, and U.S. competitiveness, and

- iii) preserving the balance between the relative value of long-term preservation and access and the associated cost and administrative burden;
- b) Ensure that all extramural researchers receiving Federal grants and contracts for scientific research and intramural researchers develop data management plans, as appropriate, describing how they will provide for long-term preservation of, and access to, scientific data in digital formats resulting from federally funded research, or explaining why long-term preservation and access cannot be justified;
- c) Allow the inclusion of appropriate costs for data management and access in proposals for Federal funding for scientific research;
- d) Ensure appropriate evaluation of the merits of submitted data management plans;
- e) Include mechanisms to ensure that intramural and extramural researchers comply with data management plans and policies;
- f) Promote the deposit of data in publicly accessible databases, where appropriate and available;
- g) Encourage cooperation with the private sector to improve data access and compatibility, including through the formation of public-private partnerships with foundations and other research funding organizations;
- h) Develop approaches for identifying and providing appropriate attribution to scientific data sets that are made available under the plan;
- i) In coordination with other agencies and the private sector, support training, education, and workforce development related to scientific data management, analysis, storage, preservation, and stewardship; and
- j) Provide for the assessment of long-term needs for the preservation of scientific data in fields that the agency supports and outline options for developing and sustaining repositories for scientific data in digital formats, taking into account the efforts of public and private sector entities.

5. Implementation of Public Access Plans

Some Federal agencies already have policies that partially meet the requirements of this memo. Those agencies should adapt those policies, as necessary, to fully meet the requirements. Once finalized, each agency should post its public access plan on its Open Government website.

The agency plan shall not apply to manuscripts submitted for publication prior to the plan's effective date or to digital data generated prior to the plan's effective date. The effective dates can be no sooner than the publication date of the agency's final plan.

OSTP will oversee implementation through regular meetings with agencies. Each agency shall provide updates on implementation to the Directors of OSTP and OMB twice yearly; these updates shall be submitted by January 1 and July 1 of each year for two years after the effective date of the agency's final plan. An agency may amend its public access plan consistent with these objectives, in consultation with OSTP and OMB.

6. General Provisions

Nothing in this memorandum shall be construed to impair or otherwise affect authority granted by law to an executive department, agency, or the head thereof; or functions of the Director of OMB relating to budgetary, administrative, or legislative proposals.

Consistent with the America COMPETES Reauthorization Act of 2010, nothing in this memorandum, or the agency plans developed pursuant to it, shall be construed to authorize or require agencies to undermine

any right under the provisions of title 17 or 35, United States Code, or to violate the international obligations of the United States. This memorandum is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity, by any party against the United States; its departments, agencies; or entities, its officers, employees, or agents; or any other person.

¹ Section 508 Of The Rehabilitation Act, as amended, available at:
<https://www.section508.gov/index.cfm?fuseAction=1998Amend>

² These policies include, but are not limited to OMB Circular A-130, Management of Federal Information Resources, available at:
http://www.whitehouse.gov/omb/circulars_a130_a130trans4)

APPENDIX H – CDOT ARIB STUDY NUMBER PROCEDURE

The Research Branch’s new procedure for assigning Study Numbers is designed to identify projects according to the general subject area, and the fiscal year. It is as follows:

Study number = [subject area code (below)]+[last two digits of fiscal year][.][two digit RIC ranking that year within subject]

For example:

Subject Area Code = 1

Last two digits of fiscal year = 14

Rank = 01

Resulting Study Number = 114.01

Subject Areas:	Subject Area Code
Environmental, Sustainability, and Water Quality:	1
Structures, Hydraulics, Soils, and Geotechnical:	2
Safety, Operations, and Planning:	3
Pavements and Materials:	4

APPENDIX I – CDOT RESEARCH IMPLEMENTATION PLAN FORM

LIST OF RESPONSIBILITIES

<u>ITEMS</u>	<u>ACTIVITIES</u>	<u>RESPONSIBLE</u>
A.	Study number	ARIB
B.	Report number (if published)	ARIB
C.	Study name	ARIB
D.	Principal investigator	ARIB
E.	Study manager	ARIB
F.	Date	ARIB
G.	Categories of implementation	SP/PL/CC
H.	Description of implementation	SP/PL/CC
I.	Implementation steps and party responsible for each	SP/PL/CC
J.	Report summary	SP/PL/CC
K.	Estimated cost of implementation	CC/PL/SS
L.	Benefits	CC/PL/SS
M.	Barriers	CC/PL/SS
N.	Method to measure benefits	CC/PL/SS
O.	Implementation close-out	CC/PL/SS

ARIB = Applied Research and Innovation Branch
 SP = Study Panel
 PL = Panel Leader//Co-Panel Leader
 CC = Champion/Co-Champion
 SS = Sponsor/Co-Sponsor

APPENDIX J – IMPLEMENTATION PLAN INSTRUCTIONS

Please put your implementation plans into the attached standardized format. If you cannot fill in the information requested for a letter, leave it blank. A-F should be completed at beginning of study.

- A. Study number
- B. Study name
- C. Principal investigator
- D. Study Manager
- E. Date of plan
- F. Category name of implementation product, use one of these terms showing both number and name
 - New Design Option
 - Design Methodology Change
 - Design Standard Change
 - Assessment Methodology Change
 - Materials Specification Change
 - Construction Specification Change
 - Planning Process Change
 - Maintenance Practice Change
 - Manual
 - New Program
 - New Technology
- G. Further description of implementation product
- H. Describe implementation steps, in consultation with study panel

APPENDIX K – CDOT- FEDERAL-AID HIGHWAY PROGRAM STEWARDSHIP AGREEMENTS, RESEARCH SECTION

COLORADO DEPARTMENT OF TRANSPORTATION
FEDERAL-AID HIGHWAY PROGRAM

STEWARDSHIP AND OVERSIGHT
AGREEMENT

March 18, 2015

DEVELOPED IN PARTNERSHIP WITH THE FEDERAL HIGHWAY ADMINISTRATION'S
COLORADO DIVISION AND THE COLORADO DEPARTMENT OF TRANSPORTATION

We support the concept of this Stewardship and Oversight Agreement and hereby direct that the stewardship and oversight of the Federal-Aid Highway Program be carried out in the spirit of a true partnership, as described herein.



Shailen P. Bhatt
Executive Director
Colorado Department of Transportation

3/31/2015
Date:



John M. Cater
Colorado Division Administrator
Federal Highway Administration

3/26/15
Date:



COLORADO
Department of
Transportation



SECTION 2. ENGINEERING: APPLIED RESEARCH AND INNOVATION

2.1. INTRODUCTION

The Research program includes activities related to transportation technology.

2.2. METHOD OF OPERATION

The role of FHWA is to conduct research of national focus and to transfer those technologies to state and local transportation agencies. The role of CDOT's Research Branch is to conduct research specific to state transportation needs and problems and to transfer technologies developed elsewhere into practice in Colorado.

2.3. CDOT ORGANIZATION

The Research, Development, and Technology Transfer program (RD&T) at CDOT is the responsibility of the Applied Research and Innovations Branch (ARIB) of the Division of Transportation Development (DTD). The Structures and Technology Applications Team will handle the Federal-aid operations of research and technology transfer activities.

The primary products are:

1. Applied research: The study of phenomena relating to a specific known need in connection with the functional characteristics of a system to answer a question or solve a problem;
2. Development: The translation of basic or applied research results into prototype materials, devices, techniques, or procedures for the practical solution of a specific problem in transportation; and
3. Technology Transfer: Dissemination, demonstration, training, and other activities that lead to the eventual deployment of a new technique or product.

2.4. FHWA ORGANIZATION

FHWA Research Program Manager is the primary liaison for research related activities with CDOT. The Manager will review final highway engineering related research reports produced by or for CDOT to ensure Federal-aid funds are appropriately used. In addition, the Manager will serve on CDOT Research Implementation Council (RIC) that is responsible for guiding and directing the research and development program. The Manager provides engineering expertise, leadership, and oversight of the Local Technical Assistance Program (LTAP). Also, the Manager serves as the principal advisor to CDOT on federal requirements for a variety of significant national studies on transportation needs.

2.5. QUALITY

The purpose of RD&T at CDOT is to save Colorado money, time, and lives, and to improve the quality of life and the environment through the development and deployment of new or innovative methods, products, or materials in the planning, design, construction, and operation of transportation. The ultimate measure of quality is how effectively this is accomplished. To meet this purpose, research must be timely, relevant and valid when applied to priority real-world problems. It must also be cost-effective, and accurately documented and disseminated. The technology must be appropriately transferred to the practitioner so as to be effectively utilized.

FHWA Colorado Division and Colorado Department of Transportation
Stewardship and Oversight Agreement

Quality is controlled in RD&T through oversight and review by experts and stakeholders. Oversight Teams and RIC are used to help focus the research program into priority areas with urgent problems to be solved. Research study panels composed of subject matter experts and practitioners with an interest in utilizing the research results are used in conjunction with each research study. A peer review of CDOT's research management process will be conducted every three years by researchers from other state DOTs after being trained in techniques for performing a peer review.

FHWA and CDOT will also develop risk response strategies of CDOT's research process when necessary.

This process is documented in the *Colorado Department of Transportation Research Procedures Manual (January 2004)*.

2.6. PERFORMANCE/COMPLIANCE MEASURES

The following performance measures will be used to assess the health of the Research Program:

Table 2 - Performance/Compliance Measures (Research)

SAP #	Measure	Description	Reporting Mechanism	Target/ Baseline	Reporting Frequency
97	Percent of recommendations implemented	Percent of recommendations implemented or adopted within two years of final research report, using 5 years of data The research findings and recommendations will impact one or more of the following: improve design and construction methods, improve design and construction specifications, improve planning processes, impact maintenance practice, update manuals, initiate new programs, and provide new technology	Research Work Plan and Report	50%	State FY
412	Number of projects completed on schedule	The number of projects completed in the fiscal year on schedule	Research Work Plan and Report	10	State FY
415	Percent of annual SPR funds spent	Percent of annual fund spent on RD&T (professional services) activities	Research Work Plan and Report	Minimum 50%	State FY
416	The annual number of classes scheduled by the LTAP Center	The number of classes scheduled by the LTAP Center	Annual Report	70	State FY
417	The annual number of people trained by the LTAP Center	The number of people who attended classes offered by the LTAP Center	Annual Report	1400	State FY
473	The annual number of people attending training on the Front Range and Eastern Plains	The number of people attending training from the Front Range and Eastern Plains	Annual Report	1000	State FY
474	The annual number of people attending training on the Western Slope	The number of people attending training from the Western Slope	Annual Report	400	State FY
475	The annual number of agencies attending training offered by the LTAP Center	The number of agencies attending training offered by the LTAP Center	Annual Report	100	State FY