



State Department of Transportation National Spatial Data Infrastructure (NSDI) Implementation

Requested by

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Executive Summary

Background

“The Spatial Data Infrastructure provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia, and citizens in general.”¹ The National Spatial Data Infrastructure (NSDI) is intended to provide a consistent means through which to share geographic data among all users in hopes of producing significant cost savings for data collection and use. NSDI encompasses the technology, policies, criteria, standards, and people involved with geospatial data. NSDI facilitates comprehensive analysis to help decision-makers choose the best course of action. The ability to make data-driven decisions for transportation system management has long been a desire [1,2].

The [Report Card on National Spatial Data Infrastructure](#)² by the Coalition of Geospatial Organizations highlights the current NSDI deficiencies. The need for improving NSDI contributions at Caltrans has also been identified in numerous studies and documents over the last 15 years. Two recent documents include: “Every Day Counts 2: Geospatial Data Collaboration” and “Geospatial Strategic Direction.” These Caltrans documents identify both the opportunity and necessity for Caltrans to improve the interoperability and sustainability of the various data and systems that present and interact with geospatial data in a manner consistent with NSDI and Federal Geographic Data Committee (FGDC) recommendations.

This Preliminary Investigation (PI) should serve as a decision-making tool for the Division of Right of Way and Land Surveys, the Geospatial Governance Committee (GGC), and the Geospatial Data Officer (GDO) in their assessment, contribution, and/or potential implementation of NSDI or specific California Spatial Data Infrastructure (SDI) within Caltrans. The PI research will consider, through the literature review and/or the survey questions, the following:

- How other states and state Departments of Transportation (DOTs) are implementing NSDI as well as best practices in implementation, operation, and maintenance of NSDI or state-specific SDI in DOTs.
- The level of NSDI implementation by other states, state DOTs, and California local agencies.
- The benefits achieved by other DOTs from implementing NSDI.
- NSDI or state-specific SDI implementation funding mechanisms, operational costs, and cost recovery mechanisms in other states and state DOTs.
- Conduct an NSDI or state-specific SDI survey of other state DOTs.

¹ SDI Cookbook 2012

http://gsdiassociation.org/images/publications/cookbooks/SDI_Cookbook_from_Wiki_2012_updated.pdf

² http://www.cogo.pro/uploads/COGO-Report_Card_on_NSDI.pdf

Summary of Findings

Caltrans Division of Right of Way and Land Surveys requests that the Division of Research, Innovation and System Information (DRISI) conduct a Preliminary Investigation (PI) to determine the state of implementation, operation, maintenance, funding mechanisms, annual operational costs, cost recovery mechanisms, and benefits of implementing the National Spatial Data Infrastructure (NSDI) core framework data for Departments of Transportation (DOTs).

Federal Organizations

The NSDI is described by federal [Executive Order 12906](#)³ (“Coordinating Geographic Data Acquisition and Access”) as “the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data.”⁴ The NSDI has become a critical vehicle for facilitating seamless data development, information sharing, and collaborative decision-making across multiple economic sectors. The Federal Geographic Data Committee (FGDC) and its partners have developed a [strategic plan](#)⁵ for the NSDI that describes a shared national vision of the NSDI and includes a set of goals and objectives for the role of federal agencies in achieving this vision. FGDC has developed and published their NSDI plans,⁶ standards, and resources for practitioners on their website.² FGDC has identified dataset or strategic themes with the highest priority and has designated leads from different federal organizations to coordinate with state and local agencies to implement and gather NSDI theme data.⁷ The lead federal agencies for core NSDI themes related to Caltrans Division of Right of Way and Land Surveys are listed in Table 1.

Table 1 Core NSDI themes related to Caltrans Division of Right of Way and Land Surveys

NSDI Theme	Agency	Sub-Agency
Cadastral	U.S. Department of the Interior	Bureau of Land Management
Elevation	U.S. Department of the Interior and U.S. Department of Commerce	U.S. Geological Survey (USGS) and National Oceanic and Atmospheric Administration (NOAA)
Geodetic Control	U.S. Department of Commerce	NOAA
Imagery	U.S. Department of the Interior and U.S. Department of Agriculture	USGS and Farm Service Agency

The FGDC Coordination Group meets regularly and provides latest updates on FGDC business activities. The [FGDC Coordination Group June 2018 meeting minutes](#)⁸ are available online. The FGDC Executive Committee determines the potential opportunity for State DOTs to be included on the upcoming NSDI Strategic Plan Update Revisions - Draft Aug 15-Sept 15 2018.

GeoPlatform.gov was created to enhance geospatial resource sharing across the U.S. Government and the world, and to allow users like you to participate in an online geospatial

³ <http://www.archives.gov/federal-register/executive-orders/pdf/12906.pdf>

⁴ <https://www.fgdc.gov/nsdi/nsdi.html>

⁵ <http://www.fgdc.gov/nsdi-plan/nsdi-strategic-plan-2014-2016-FINAL.pdf>

⁶ https://www.fgdc.gov/nsdi-plan/index_html

⁷ https://www.fgdc.gov/ngda-reports/Theme_Leads.html

⁸ www.fgdc.gov/organization/coordination-group/meeting-minutes/2018/june/fgdc-business-report-cg-20180612.pptx

services experience. GeoPlatform.gov is a place to stay connected to a fast evolving geospatial service ecosystem.

In the past, FGDC has provided NSDI Cooperative Agreements Program (CAP) grants⁹ as part of an annual program to assist the geospatial data community through funding and other resources in implementing the components of the NSDI. The program provided small seed grants to state, local, and tribal governments as well as academia, commercial, and non-profit organizations to initiate sustainable, on-going NSDI implementations. CAP emphasized partnerships, collaboration, and the leveraging of geospatial resources in achieving its goals. The NSDI CAP grant program ended in 2013. Many states benefited from this 9-year program.¹⁰ The following are some of the NSDI CAP results that may be useful for Caltrans.

- The Indiana Geographic Information Council (IGIC) completed a [return on investment \(ROI\) study](#)¹¹
- Strategic and business plans: [Idaho](#),¹² [Illinois](#),¹³ [Missouri](#),¹⁴ and [Utah](#)¹⁵
- Strategic plans: the [District of Columbia](#),¹⁶ [Georgia](#),¹⁷ [New York](#),¹⁸ [Pennsylvania](#),¹⁹ and [Texas](#)²⁰
- [North Carolina](#)²¹ business case for NC OneMap
- [Iowa](#)²² Strategic Return on Investment Business Plan for Iowa Geospatial Infrastructure
- Missouri [“How to” Guide](#)²³ designed to help local governments with geographic information technology
- Iowa fact sheet entitled [“A Spatial Data Infrastructure for Iowa – Why it’s Needed”](#)²⁴
- [Hawaii Geographic Information Coordinating Council \(HIGICC\) Business Plan for Imagery, Metadata, and GIS Data Portal](#)²⁵

Data.gov

Data.gov is managed and hosted by the U.S. General Services Administration, [Technology Transformation Service](#).²⁶ Data.gov hosts many good examples of NSDI data. Data.gov is

⁹ <https://www.fgdc.gov/grants>

¹⁰ <https://www.fgdc.gov/grants/AchievementEvaluation>

¹¹ <https://www.fgdc.gov/grants/2007CAP/Reports/042-07-3-IL-ROIReport.pdf>

¹² <https://www.fgdc.gov/grants/2008CAP/projects/08HQAG0007>

¹³ <https://www.fgdc.gov/grants/2007CAP/projects/07HQAG0041>

¹⁴ <https://www.fgdc.gov/grants/2007CAP/projects/07HQAG0040>

¹⁵ <https://www.fgdc.gov/grants/2007CAP/projects/07HQAG0034>

¹⁶ <https://www.fgdc.gov/grants/2007CAP/projects/07HQAG0156>

¹⁷ <https://www.fgdc.gov/grants/2008CAP/projects/08HQAG0008>

¹⁸ <https://www.fgdc.gov/grants/2007CAP/projects/07HQAG0036>

¹⁹ <https://www.fgdc.gov/grants/2008CAP/projects/08HQAG0014>

²⁰ <https://www.fgdc.gov/grants/2006CAP/projects/06HQAG0106>

²¹ <https://www.fgdc.gov/grants/2006CAP/projects/06HQAG0105>

²² <https://www.fgdc.gov/grants/2007CAP/projects/07HQAG0043>

²³ <https://www.fgdc.gov/grants/2007CAP/Reports/040-07-3-MO-How-To-Guide-Narrative.pdf>

²⁴ https://www.fgdc.gov/grants/2007CAP/Reports/043-07-3-IA-Factsheet1_IGIoverview.doc

²⁵ <https://www.fgdc.gov/grants/2010CAP/InterimFinalReports/168-10-4-HI-HIGICCBusinessPlan-Final20101002.pdf>

²⁶ <http://www.gsa.gov/portal/category/25729>

powered by the open-source application Comprehensive Kerbal Archive Network (CKAN).²⁷ CKAN is a data management system and data portal platform that makes data accessible by providing tools to streamline publishing, sharing, finding, and using data. CKAN has a well-documented Application Program Interface (API) for developers to access data hosted in the data portal platform. Data.gov's CKAN implementation source code may be found at [GitHub](#).²⁸

The European Union's Infrastructure for Spatial Information in Europe ([INSPIRE](#))²⁹ published NSDI [data standard and specifications](#),³⁰ [roadmap](#),³¹ [best practices](#),³² and an [implementation guide](#)³³ for member countries.

California

Michael Baker, Jr., Inc. wrote a [California Geospatial Framework Draft Data Plan](#)³⁴ for the [California Geographic Information Association](#) (CGIA)³⁵ in partnership with US Geological Survey (USGS), California Resources Agency, and the [California GIS Council](#) (CGC)³⁶ in 2006. Seven core framework data themes were prioritized as follows (from highest priority to lowest): 1. Cadastral, 2. Orthoimagery, 3. Transportation, 4. Elevation, 5. Hydrography, 6. Geodetic Control, and 7. Governmental Units. The [California Geospatial Framework Draft Data Plan](#) provided detailed information about each core theme including description, uses, data sources, standards, lead agencies, requirements, and current and future challenges. The [California Geospatial Framework Draft Data Plan](#) recommended short and long-term goals for California. Google searches did not yield any California statewide efforts in planning or implementation of NSDI themes. CGA and CGIA published a [California GIS Strategic Plan Phase 2](#)³⁷ in 2008, and CGC adopted the [California GIS Council Charter](#)³⁸ in 2015. The [California GIS Strategic Plan Phase 2](#) provided recommendations related to data governance, data standards, policies, goals, funding, and implementation details that may be employed by Caltrans. Several core framework data theme working groups have been established through the California GIS Council.³⁹ CGIA's [resources webpage](#)⁴⁰ and the [regional GIS collaborative contract information](#) webpage⁴¹ provide crucial data to initiate collaboration with local agencies.

Scott Gregory, [California Department of Technology](#)⁴² (CDT) Geographic Information Officer (GIO), presented the [CDT GIO's roles](#),⁴³ CDT's API, and CDT's data portal at the San Diego Regional GIS Council meeting in 2011. The California Office of Emergency Services (OES) has

²⁷ <http://ckan.org/>

²⁸ <https://github.com/GSA/data.gov/>

²⁹ <https://inspire.ec.europa.eu/>

³⁰ <https://inspire.ec.europa.eu/data-specifications/2892>

³¹ <http://inspire.ec.europa.eu/inspire-roadmap/61>

³² https://inspire.ec.europa.eu/file/1576/download?token=_MbXVagy

³³ <http://inspire.ec.europa.eu/quick-overview-implementers/57528>

³⁴ <https://www.fgdc.gov/grants/2005CAP/Reports2005/130-05-3-CA-FinalReport.pdf>

³⁵ <http://cgia.org/>

³⁶ <http://cgia.org/cagiscouncil/>

³⁷ http://sdr gc.org/Documents/Docs/docs_20150114/CA-StrategicPlan-P2.pdf

³⁸ http://sdr gc.org/Documents/Docs/docs_20150114/CA_GIS_Council_Charter-Adopted01072015.pdf

³⁹ <http://cgia.org/cagiscouncil/category/workgroups/>

⁴⁰ <http://cgia.org/learning-resources/general-resources/>

⁴¹ <http://cgia.org/cgia-collaboration/regional-gis-collaboratives/regional-gis-collaboratives-contact-information/>

⁴² <https://cdt.ca.gov/>

⁴³ http://sdr gc.org/Documents/Docs/docs_20110413/CalGIS_Keynote.pptx

posted their [GIS Concept of Operations](#)⁴⁴ on the website detailing their GIS requirements (Minimum Essential Data Sets (MEDS) and Essential Elements of Information (EElS)). Michael Baker, Jr., Inc. developed a “Final Proposed Architectural Design Document California Minimum Essential Datasets”⁴⁵ for the California Office of the State Chief Information Officer in 2010, providing a detailed architectural design for delivering SDI data via web, API, and USB drives. “Final Data Availability Document California Minimum Essential Datasets,”⁴⁶ developed by Michael Baker, Jr., Inc. for the California Office of the State Chief Information Officer in 2009, provides a list of SDI resources from California local agencies.

California Local Agencies

The Southern California Government GIS ([SoCalGIS](#))⁴⁷ User Group is a local government GIS user group serving Los Angeles County and Orange County area municipalities, local government agencies, education, and non-profits using GIS. The [SoCalGIS resources website](#)⁴⁸ provides a list of hyperlinks to many southern California cities, counties, metropolitan planning organizations (MPOs), and state Geographic Information System (GIS) libraries.

Los Angeles (LA) County enterprise GIS has collaborated with cities within their county-created [data portal](#),⁴⁹ which contains core NSDI theme data. LA County has also hosted LA regional GIS meetings and provides [documents](#),⁵⁰ details of practical GIS implementation issues, and new and interesting applications of GIS to improve transportation.

The City of LA provides their GIS and NSDI data, including parcel data, on their open data portal [GeoHub website](#).⁵¹ Some LA city GIS data is hosted by [arcgis.com](#).

Orange County (OC), California has [studied the use of giscloud.com](#)⁵² to host their GIS data, including NSDI theme data such as parcel data. OC provides a GIS data portal at [ocdata.giscloud.com](#)⁵³ and OC parcel data on the [ocgov.com/octaxmap](#)⁵⁴ website.

San Diego Regional GIS Council (SDRGC) provides [documents](#)⁵⁵ and hosted regular working group [meetings](#)⁵⁶ to foster the collaboration of local cities and agencies. SDRGC past meeting presentations included status and implementation details of NSDI themes.

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http://www.caloes.ca.gov/GeographicInformationSystemsSite/Documents/2017_05%20Cal%20OES%20GIS%20Concept%20of%20Operations.pdf

45 File named “MEDS Architecture.pdf”

46 File named “MEDS Data Availability.pdf”

47 <https://socialgis.org/>

48 <https://socialgis.org/resources/>

49 <https://egis3.lacounty.gov/eGIS/get-gis-data/>

50 <https://egis3.lacounty.gov/eGIS/egis-home/documents/>

51 <http://geohub.lacity.org/>

52 <https://www.giscloud.com/blog/orange-county-gis-cloud-case-study/>

53 <https://ocdata.giscloud.com/>

54 <http://ocgov.com/octaxmap>

55 <http://sdrgc.org/Documents/docs.html>

56 <http://sdrgc.org/WGroups/wgroups.html>

Marin County Community Development Agency⁵⁷ delivers their GIS data via the [Marin Map](#)⁵⁸ data portal, including aerial images, survey benchmarks, parcels, and streetlights. Marin Map contains data from [members](#),⁵⁹ which includes cities and local agencies within Marin County.

In 2002, [Bay Area Automated Mapping Association](#)⁶⁰ (BAAMA, now [BayGeo](#)),⁶¹ performed a [Bay Area GIS Survey](#)^{62, 63, 64} to build the foundation for GIS data sharing/exchange and metadata awareness/usage in the San Francisco Bay Area (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties) and the City of Santa Cruz.

[Contra Costa County GIS](#)⁶⁵ provides their NSDI and GIS data on Dropbox.com (parcels, geodetic, Light Detection and Ranging (LiDAR), orthophotos, and planning) and an [interactive map website](#).⁶⁶ [Sacramento Area Council of Governments](#)⁶⁷ (SACOG) [Open Data portal](#),⁶⁸ [Yolo County data portal](#),⁶⁹ [City of Woodland Map Library](#),⁷⁰ and [City of Davis mapping and GIS](#)⁷¹ also provide extensive lists of GIS and NSDI theme data online. There may be many more California cities, counties, and MPOs that provide rich NSDI theme datasets, such as parcels, high-resolution images, and survey benchmark datasheets. The author did not find a comprehensive list of all GIS/NSDI theme data sources for all California agencies.

Caltrans

Caltrans DRISI assembled a team of Caltrans geospatial subject matter experts to examine how Caltrans can enhance collaboration through the use of geospatial data. The Federal Highway Administration's (FHWA) "Every Day Counts Round 2 Geospatial Data Collaboration Initiative Recommendations to Improve Caltrans Geospatial Data Collaboration" report contains specific recommendations to improve Caltrans' ability to create, maintain, and share authoritative, quality transportation data. The Geospatial Strategic Direction Value Analysis Study team compiled a list of Strengths, Weaknesses, Opportunities and Threats (SWOT) related to geospatial efforts using input from Caltrans geospatial managers and staff. The Geospatial Strategic Direction Value Analysis Study team also identified core NSDI themes, NSDI theme definitions, data owners/maintainers, internal partners, external partners, and Information Technology (IT) needs. Caltrans is an active participant in the Cal GIS Council Geodetic Control Workgroup.

⁵⁷ <https://www.marincounty.org/depts/cd/divisions/mapping>

⁵⁸ <http://www.marinmap.org/dnn/>

⁵⁹ <http://www.marinmap.org/dnn/AboutMarinMap/Members.aspx>

⁶⁰ <http://www.baama.org/>

⁶¹ <http://baygeo.org/>

⁶² http://www.baama.org/Resources/Documents/survey/survey_summary_report.pdf

⁶³ http://www.baama.org/Resources/Documents/survey/survey_contacts.pdf

⁶⁴ http://www.baama.org/Resources/Documents/survey/survey_detailed_results.pdf

⁶⁵ <http://www.co.contra-costa.ca.us/1818/GIS>

⁶⁶ <https://gis.cccounty.us/Html5//index.html?viewer=CCMAP>

⁶⁷ <https://www.sacog.org/>

⁶⁸ <https://data-sacog.opendata.arcgis.com/>

⁶⁹ <http://www.yolocounty.org/general-government/general-government-departments/general-services/geographic-information-system-gis/data-downloads>

⁷⁰ <http://www.cityofwoodland.org/gov/depts/adminsrvs/is/gis/maplibrary.asp>

⁷¹ <http://cityofdavis.org/city-hall/information-systems/gis>

Other United States (US) States Agencies

Florida DOT (FDOT) published “Phase I of an Enterprise Geographical Information System (GIS) for Transportation.”⁷² The FDOT GIS⁷³ website provides FDOT’s GIS policy and governance⁷⁴ and link to the FDOT data portal.⁷⁵ FDOT integrates their GIS, Civil Integrated Management (CIM), and data governance efforts.

The Georgia Spatial Data Infrastructure (GaSDI),⁷⁶ Georgia Geospatial Advisory Council (GGAC),⁷⁷ and the Georgia GIS Clearinghouse,⁷⁸ hosted by the Georgia Institute of Technology and the University of Georgia, provide a document library⁷⁹ for Georgia’s GIS technical documents, including a report⁸⁰ and presentation⁸¹ on the “Sustainability Study for Georgia Geographic Information Office” by Polis Center at Indiana University and Purdue University, Indianapolis.

The Iowa Geographic Information (IGI) Council⁸² document repository provides documents related to the development of a spatial data infrastructure for Iowa, including the Iowa Geospatial Infrastructure Return on Investment Studies 2007-2012,⁸³ IGI FGDC presentation 2012,⁸⁴ and IGI factsheet.⁸⁵ The IGI Council website also offers links to Iowa data portals containing NSDI theme data.

IndianaMap⁸⁶ is the largest publicly available collection of Indiana GIS data. IndianaMap is a network of partnerships⁸⁷ and collaborations between federal, state, and local organizations, agencies, and universities. Data, management, maintenance, and costs are spread across many partners to leverage the expertise and efforts of many to forge the IndianaMap alliance. With a FGDC grant, IndianaMap provides its GIS return on investment (ROI) report⁸⁸ and web links to Indiana GIS resources.⁸⁹ The Indiana Spatial Data Portal⁹⁰ provides access to more than 30 terabytes of Indiana geospatial data.

⁷² http://www.fdot.gov/research/Completed_Proj/Summary_Map/FDOT_BDI40_rpt.pdf

⁷³ <http://www.fdot.gov/gis/>

⁷⁴ <http://www.fdot.gov/it/OITManual/Chapter22GISInfoTechnologyResourceUsersManual.pdf>

⁷⁵ <http://www.fdot.gov/agencyresources/mapsanddata.shtm>

⁷⁶ <https://www.georgiaspatial.org/>

⁷⁷ <https://www.georgiaspatial.org/ggac>

⁷⁸ <https://data.georgiaspatial.org/login.asp?CookieTest=2>

⁷⁹ <https://www.georgiaspatial.org/technical-documents/all>

⁸⁰

<https://www.georgiaspatial.org/sites/default/files/presentations/home/Polis%20Center%20GIO%20Report%20Final%20-%20031215.pdf>

⁸¹

<https://www.georgiaspatial.org/sites/default/files/presentations/home/Polis%20Center%20GIO%20Final%20Presentation%20031215.pdf>

⁸² <https://www.iowagic.org/>

⁸³ <https://www.iowagic.org/wp-content/uploads/2008/06/IGI-Final-Report.pdf>

⁸⁴ https://www.iowagic.org/wp-content/uploads/2013/08/What-is-IGI_2012_FGDCtalk.pdf

⁸⁵ https://www.fgdc.gov/grants/2007CAP/Reports/043-07-3-IA-Factsheet1_IGIoverview.doc/at_download/file

⁸⁶ <http://www.indianamap.org/about.php>

⁸⁷ <http://www.indianamap.org/partners.php>

⁸⁸ https://www.fgdc.gov/grants/2007CAP/Reports/042-07-3-IL-ROIReport.pdf/at_download/file

⁸⁹ <http://www.indianamap.org/resources.php>

⁹⁰ <http://gis.iu.edu/>

The Missouri Geographic Information Systems Advisory Council (MGISAC)⁹¹ was established as a standing committee under Missouri's Chief Information Officer (CIO) to enhance the use of GIS at the local, state, and federal levels through the sharing of GIS products, including GIS standards,⁹² strategic planning,⁹³ and data development.⁹⁴

The Minnesota Geospatial Information Office (MnGeo),⁹⁵ led by the Minnesota Chief Geospatial Officer, functions are provided through a budgetary appropriation. Funding for project consulting is provided on a cost-recovery basis through contracts with other agencies. MnGeo's "A Foundation for Coordinated GIS Minnesota's Spatial Data Infrastructure"⁹⁶ report, adopted by the MN Governor's Council on Geographic Information in 2004, provides a detailed roadmap for Minnesota's NSDI implementation. MnGeo's website page contains a wealth of useful information for NSDI implementation.⁹⁷

The New Mexico (NM) Legislature created the Resource GIS (RGIS)⁹⁸ Program and designated the NM RGIS Program as the state digital geospatial data clearinghouse.⁹⁹ This designation recognizes the key role that geospatial data plays in the continued development of the NM state's agencies, economy, and educational and research capacities. RGIS data clearinghouse, hosted by the University of New Mexico, provides NDSI theme data in NM as well as best practices documentation¹⁰⁰ for GIS practitioners.

The North Carolina Department of Transportation's (NCDOT) GIS and NSDI Standards and Practices is available online.¹⁰¹ North Carolina (NC) OneMap,¹⁰² directed by the North Carolina Geographic Information Coordinating Council (GICC), is the geospatial data backbone supporting NC data users. In 2003, the NC GICC adopted the NC OneMap Initiative in partnership with county, municipal, state, and federal data providers. The NC OneMap Initiative website¹⁰³ contains NC's vision for geospatial data standards; data currency, implementation plan, maintenance, and accessibility; data documentation (i.e. metadata); and a statewide GIS inventory. Thirty-seven priority data themes were selected as the initial focus.

The University of Oregon Libraries' Maps and GIS Resources website¹⁰⁴ has a long list of GIS data available throughout the U.S., including many state agencies, state counties, and cities. However, some links may be broken since the webpage does not have a last updated date.

The Washington State Department of Transportation's (WSDOT) GeoData Distribution Catalog,¹⁰⁵ maintained by the Office of Information Technology, is a centralized distribution site for geographic information system data produced at the WSDOT.

⁹¹ <https://mgisac.org/>

⁹² <https://mgisac.org/gis-standards/>

⁹³ <https://mgisac.org/committees/strategic-planning/>

⁹⁴ <https://mgisac.org/committees/data-development/>

⁹⁵ <http://www.mngeo.state.mn.us/>

⁹⁶ http://www.mngeo.state.mn.us/MSDI/MN_IPlan_Consolidation_Final_04OCT04.pdf

⁹⁷ <http://www.mngeo.state.mn.us/MSDI/dte/index.html>

⁹⁸ <http://rgis.unm.edu/about/>

⁹⁹ <http://rgis.unm.edu/getdata/>

¹⁰⁰ <http://rgis.unm.edu/category/gisinpractice/>

¹⁰¹ <https://connect.ncdot.gov/resources/gis/Pages/GIS-Standards.aspx>

¹⁰² <http://www.nconemap.com/Default.aspx?tabid=289#initiative>

¹⁰³ <http://www.nconemap.com/Default.aspx?tabid=289#initiative>

¹⁰⁴ https://library.uoregon.edu/map/map_section/map_Statedatasets

¹⁰⁵ <http://www.wsdot.wa.gov/mapsdata/geodatacatalog/>

NSDI Themes

The Caltrans Office of Land Surveys (OLS) has studied CGIA and CGC's [California Geospatial Framework Draft Data Plan](#) and circulated a document called "Surveying and the National Spatial Data Infrastructure Core Framework Themes,"¹⁰⁶ stating the NSDI themes for which Surveys and Right of Way and/or Photogrammetry are responsible. The [Caltrans GIS Data Library](#)¹⁰⁷ has transportation-related GIS data, but does not provide any data on the four core NSDI data themes for which the Surveys/Right of Way Engineering and Photogrammetry are responsible.

Table 2 Core California NSDI theme in order of priority according the CGIA and CGC survey¹⁰⁸ and data source (responsibile unit) according to a Caltrans Office of Land Surveys study

NDSI Themes	Map Use	Data Source
Cadastral	Define structure of the subdivision and ownership of land	Surveys/Right of Way Engineering
Ortho Imagery	Map Background	Photogrammetry & Enterprise GIS
Transportation	Model the location, connection, and characteristics of roads	Design
Elevation	Provide 3rd dimension information to GIS data	Surveys/Photogrammetry
Hydrography	Surface water features such as lakes, ponds, streams, etc.	Hydraulics
Geodetic Control	Provide a common reference for all geospatial data	Surveys
Governmental Units	Governmental boundaries, zones, districts, etc.	Office of GIS

¹⁰⁶ See file named "NSDI Core Themes and Surveys.pdf"

¹⁰⁷ <http://www.dot.ca.gov/hq/tsip/gis/datalibrary/index.php>

¹⁰⁸

http://sdrgc.org/Documents/Docs/docs_20150114/CA_GeoFrame_DDP_FINAL_for_Publication.pdf

Cadastre

The U.S. Bureau of Land Management (BLM) is the leading federal agency facilitating the NSDI cadastral theme (real property data). However, local jurisdictions are often the authoritative source. BLM provides a number of [documents](#)^{109,110,111,112,113,114} and [cadastral metadata guidelines](#)¹¹⁵ to facilitate local jurisdictions publishing their cadastral survey data. BLM also surveyed and published [cadastral dataset availability](#)¹¹⁶ for all of the U.S. in January 2018. FGDC has also developed a [strategic plan](#),¹¹⁷ an [implementation plan](#),¹¹⁸ a [reference document](#)¹¹⁹ for the cadastral theme in 2012, [cadastral survey tools](#),¹²⁰ and [cadastral training material](#).¹²¹ The National Research Council published “[National Land Parcel Data: A Vision for the Future](#)”¹²² [3]. The FGDC Cadastral Subcommittee [Cadastral PLSS Stewardship document](#)¹²³ addresses Trusted Data Publishers based on business needs and provides best practices to prevent geographic slivers and data misalignments. USGS’s [National Map website](#)¹²⁴ provides detailed information on the Public Land Survey System (PLSS). The FGDC Cadastral Subcommittee has developed a template for use in developing State business plans for cadastral information that can be developed in harmony with State strategic plans.¹²⁵

The [National Integrated Land System \(NILS\) project](#)¹²⁶ is the first step in providing a common solution for the sharing of land record information within the government and with the private sector. NILS is a joint development project between the U.S. BLM and the U.S. Forest Service in partnership with states, counties, and private industry to develop a common data model and a set of software tools for the collection, management, and sharing of land survey data, cadastral data, and land record information. NILS was developed incrementally in four modules: Survey Management, Measurement Management, Parcel Management, and GeoCommunicator. The first three modules are fully integrated within a custom workflow management system that works

¹⁰⁹ <https://www.nationalcad.org/CadStandards/CadStand.html>

¹¹⁰ <http://nationalcad.org/download/CadastralNSDIReferenceDocument.pdf>

¹¹¹ <http://nationalcad.org/download/standard-compliance-pub-data-v1.pdf>

¹¹² <http://nationalcad.org/download/CadNSDI-Version2-Documentation.zip>

¹¹³ <http://nationalcad.org/download/PublicationHandbookOct2016.pdf>

¹¹⁴ <https://www.nationalcad.org/RefDocs/Refdocs.html>

¹¹⁵ <https://www.nationalcad.org/CadStandMetadata/CadStandMetadata.html>

¹¹⁶ <http://nationalcad.org/download/PLSS-CadNSDI-Data-Set-Availability.pdf>

¹¹⁷ https://communities.geoplatform.gov/ngda-cadastre/wp-content/uploads/2017/11/Cadastral_Strategic_Plan_Final_April_2017.pdf

¹¹⁸ https://communities.geoplatform.gov/ngda-cadastre/wp-content/uploads/2017/11/Cadastral_Implementation_Progress_April_2017.pdf

¹¹⁹ <http://nationalcad.org/download/CadastralNSDIReferenceDocument.pdf>

¹²⁰ <https://www.blm.gov/programs/lands-and-reef/cadastral-survey/cadastral-tools>

¹²¹ <https://www.fgdc.gov/training/nsdi-training-program/materials/framework-training-cadastral.pptx>

¹²² <https://www.nap.edu/catalog/11978/national-land-parcel-data-a-vision-for-the-future>

¹²³ http://nationalcad.org/download/PLSS_Stewardship.pdf

¹²⁴ https://nationalmap.gov/small_scale/a_plss.html

¹²⁵ <https://www.fgdc.gov/resources/whitepapers-reports/annual%20reports/2008/web-version/AppendixC.html>

¹²⁶ <http://people.tamu.edu/~alawing/materials/ESSM464/NILS.pdf>

with COTS products such as ESRI's ArcGIS. The BLM has a [California Cadastral PLSS geodatabase](#)¹²⁷ available via the BLM [GeoCommunicator](#)¹²⁸ website.¹²⁹

J. Eric Culp, GIS Project Manager of San Diego County Assessor's Mapping Division, presented "County of San Diego Assessor Parcel Maintenance Plans"¹³⁰ and "County of San Diego Assessor Maintained Parcels: An Update on Integrating Workflows with SanGIS"¹³¹ at San Diego Regional GIS Council (SDRGC) meetings in 2014 and 2016 respectively. Many California local jurisdictions, such as the [City of Davis](#),¹³² provide parcel data via web-based maps or shapefiles. Some counties and regional GIS organizations, such as [Sacramento County](#)^{133, 134} and [OC](#),¹³⁵ often collaborate with regional cities to collect and publish their GIS data including cadastral data.

[Minnesota Cadastral I-Plan Version 1.2](#)¹³⁶ was published by the [Parcels and Land Records Committee of the Minnesota Geospatial Advisory Council](#)¹³⁷ to support the implementation of Minnesota's cadastral theme. The Parcels and Land Records Committee of the Minnesota Geospatial Advisory Council meets regularly and provides meeting minutes and presentation files on their website. MnGeo provides "A Business Plan for Statewide Parcel Data Integration for Minnesota"¹³⁸ on its website.

Utah.gov's [discusses the state's role in the PLSS data theme](#).¹³⁹ Utah State provides a PLSS web-based map.¹⁴⁰ Both Utah State PLSS data and PLSS software are available online.¹⁴¹

Oregon.gov's [PLSS Stewardship Model](#) is also available online.¹⁴²

Edgar Kraus, et al. of Texas A&M Transportation Institute presented "[Strategies to Optimize Right-of-Way Parcel and Utility Information Management](#)"¹⁴³ at the Transportation Research Board 93rd Annual Meeting. Kraus, et al.'s paper summarizes the results of research conducted to assist the FDOT in developing a strategic implementation plan for the management of right of way parcel and utility data at the FDOT.

[California Cadastral Mapping Association](#)¹⁴⁴ (CCMA) is a professional organization comprised of individuals actively employed throughout the State of California in any Assessors' Office, whose duties include direct or indirect association with cadastral mapping. CCMA hosts conferences

¹²⁷ https://navigator.blm.gov/data?keyword=plss&fs_publicRegion=California

¹²⁸ https://www.fgdc.gov/geospatial-lob/documents/BLM_NILS_geocommunicator_factsheet.pdf

¹²⁹ <https://navigator.blm.gov/>

¹³⁰ http://sdrgc.org/Documents/Docs/docs_20141008/APM_SDRGC_EricCulp.pdf

¹³¹ http://sdrgc.org/Documents/Docs/docs_20161012/2016-10-12_SDRGC_APM_.pdf

¹³² <http://maps.cityofdavis.org/library/>

¹³³ http://generalmap.gis.saccounty.net/JSViewer/county_portal.html

¹³⁴ <http://data-sacramentocounty.opendata.arcgis.com/datasets/parcel-centroids>

¹³⁵ <http://www.ocgis.com/ocpw/LandRecords/>

¹³⁶ http://www.mngeo.state.mn.us/committee/cadastral/MN_IPlan_LRM_v1.2.pdf

¹³⁷ <http://www.mngeo.state.mn.us/committee/cadastral/index.html>

¹³⁸ http://www.mngeo.state.mn.us/coord/parcel_business_plan/index.html

¹³⁹ <https://gis.utah.gov/big-happenings-with-public-land-survey-system-gis/>

¹⁴⁰ <https://plss.utah.gov/>

¹⁴¹ <https://gis.utah.gov/developer/applications/plss/>

¹⁴²

ftp://ftp.gis.oregon.gov/MINUTES/FIT/TEAMS/CADASTRAL/WORKGROUP_PLSS/2006/2006.03.00.pdf

¹⁴³ <http://docs.trb.org/prp/14-2242.pdf>

¹⁴⁴ <http://www.calmapping.org/>

regularly. The [California Assessors' Association](#)¹⁴⁵ (CAA), a statewide non-profit professional association for county assessors formed in December 1902, published [contact information](#)¹⁴⁶ for California county assessors. Coordinated Legal Technologies' [California GIS Map & Information Sites webpage](#)¹⁴⁷ has links to many California county and city resources for online GIS mapping and information. The [LA County GIS data portal](#)¹⁴⁸ hosted a [California statewide parcel dataset](#)¹⁴⁹ (3.4 GB): a collection of all the parcel boundary datasets collected during the last round of parcel data collection by the Information Center for the Environment under funding from the California Strategic Growth Council in 2014.

The [California GIS Council Workgroup – Digital Land Records \(DLRI\)](#)¹⁵⁰ developed a [draft charter](#)¹⁵¹ containing its missions and objectives in 2016. According to [California Mapping Coordination Committee meeting minutes](#)¹⁵² in February 15, 2012, the California Technology Agency (CTA), currently known as the California Department of Technology, purchased three years use of [LandVision](#)¹⁵³ (parcel data services) that can be shared across California and to stakeholders (anyone working on a combined state-local or state-federal project) and web services.

Google searches did not yield any central data portal for all California cadastral data nor for Caltrans' properties boundary data. Caltrans districts may have cadastral theme data via the Caltrans' intranet. The author did not search through every California city, county, and MPO for their cadastral data availability.

Ortho Imagery

FGDC provides "[Imagery Theme of the National Spatial Data Infrastructure Strategic Plan 2017 -2020](#)"¹⁵⁴ and "[Theme Implementation Plan for Imagery Theme](#)"¹⁵⁵ to assist local jurisdictions in implementing the Orthoimagery Theme.

The [National Agriculture Imagery Program](#) (NAIP),¹⁵⁶ administered by the U.S. Department of Agriculture's (USDA) Farm Service Agency (FSA) through the Aerial Photography Field Office in Salt Lake City, acquires aerial imagery during the agricultural growing seasons in the continental U.S. at 1-meter resolution (see [coverage map](#)).¹⁵⁷ [NAIP California 2016 60-cm](#)¹⁵⁸ orthoimagery may be accessed via the [ArcGIS.com website](#). One-foot leaf-off orthoimagery

¹⁴⁵ <http://calassessor.org/index.php/resources/links>

¹⁴⁶ <http://calassessor.org/index.php/resources/links?task=weblink.go&id=7>

¹⁴⁷ <http://www.coordinatedlegal.com/gis.html>

¹⁴⁸ <https://egis3.lacounty.gov/dataportal/>

¹⁴⁹ <http://egis3.lacounty.gov/dataportal/2015/09/11/california-statewide-parcel-boundaries/>

¹⁵⁰ <http://cgia.org/cagiscouncil/category/workgroups/digital-land-records-dlri/>

¹⁵¹ gia.org/cagiscouncil/wp-content/uploads/2016/03/Workgroup-Status-Reports-March-2016.pdf

¹⁵² https://cagis.water.ca.gov/documents/859453/2698808/2012_February_Minutes_-_CMCC.docx?version=1.0&targetExtension=pdf

¹⁵³ <https://www.digmap.com/our-products/landvision/>

¹⁵⁴ https://communities.geoplatform.gov/ngda-imagery/wp-content/uploads/2017/12/Imagery_Strategic_Plan_FY2016_20160715.pdf

¹⁵⁵ https://communities.geoplatform.gov/ngda-imagery/wp-content/uploads/2017/12/Imagery-Theme-Implementation-Plan_Final_04192017_0.pdf

¹⁵⁶ <https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/index>

¹⁵⁷ https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdfiles/APFO/NAIP_Covg_20150512.pdf

¹⁵⁸ https://gis.apfo.usda.gov/arcgis/rest/services/NAIP/California_2016_60cm/ImageServer

over 133 urban areas were acquired by the USGS in partnership with the National Geospatial-Intelligence Agency (NGA) and state and local governments under the Homeland Security Infrastructure Program (HSIP).¹⁵⁹ The [National Digital Orthophoto Program \(NDOP\)](#)¹⁶⁰ leads the effort to complete and maintain national orthoimagery coverage with 1-m or finer resolution. The NDOP data is available at the [USGS EarthExplorer website](#).¹⁶¹

The Caltrans Office of Data Services and Technology (ODST) has licensed orthoimagery from Google Imagery Services for areas within a 1-mile buffer of Caltrans' highway network. Google Imagery provides 6-inch pixel resolution in urban areas with +/- 1-meter horizontal accuracy. Previously, the Caltrans [Digital Highway Inventory Photography Program \(DHIPP\)](#),¹⁶² comprised of ortho-rectified, geo-referenced, color, digital, aerial, and high-resolution (0.3 m pixel) imagery, provided orthoimagery along Caltrans highways. Both orthoimagery datasets are subject to license restrictions, preventing Caltrans from sharing the information outside of Caltrans. Caltrans Office of Photogrammetry (OoP) provides 0.25-foot pixel resolution digital orthoimagery for most of its photogrammetric and aerial LiDAR design scale mapping projects. This imagery is currently delivered to specific District Offices.

The CGIA [Imagery Business Plan and Best Practices Project](#) webpage provides a "[CA Imagery Business Plan Best Practices Final Report](#)"¹⁶³ and "[Imagery Business Plan & Best Practices Project](#)"¹⁶⁴ PowerPoint presentation. "Final Data Availability Document California Minimum Essential Datasets,"¹⁶⁵ developed by Michael Baker, Jr., Inc. for the California Office of the State Chief Information Officer in 2009, provides list of ortho images resources from national and local California agencies.

The [Missouri GIS Advisory Council's](#)¹⁶⁶ Data Development Committee developed the [Missouri State Wide Imagery Program](#)¹⁶⁷ for statewide leaf-off imagery by pooling Missouri's local agencies resources to acquire high-resolution orthoimagery.

[Washington Geospatial Open Data Portal](#)¹⁶⁸ hosted Washington State's [orthoimagery](#),¹⁶⁹ including historical Washington statewide NAIP imagery for download. MnGeo also provides Minnesota statewide [orthoimagery on its website](#).¹⁷⁰

Some California cities and counties, such as [Davis \(year 2005\)](#)¹⁷¹ and [Marin County](#)¹⁷² provide high-resolution orthoimagery at their GIS data portals. The author did not search through every California city, county, and MPO for orthoimagery data availability.

¹⁵⁹ <https://pubs.usgs.gov/fs/2009/3055/pdf/FS2009-3055.pdf>

¹⁶⁰ https://lta.cr.usgs.gov/high_res_ortho

¹⁶¹ <https://earthexplorer.usgs.gov/>

¹⁶² <http://www.dot.ca.gov/hq/oppd/pdwt/p17.htm>

¹⁶³ http://cgia.org/wp-content/uploads/2011/10/CA_Imagery_Business_Plan__Best_Practices_Final_Report.pdf

¹⁶⁴ http://cgia.org/wp-content/uploads/2011/10/CA_BusinessPlanPresentation_2008.pps

¹⁶⁵ File named "MEDS Data Availability.pdf"

¹⁶⁶ <https://mgisac.org/>

¹⁶⁷ <http://www.flymoimagery.com/>

¹⁶⁸ <http://geo.wa.gov/>

¹⁶⁹ <http://geo.wa.gov/datasets?t=imagery>

¹⁷⁰ <http://www.mngeo.state.mn.us/chouse/airphoto/index.html>

¹⁷¹ <http://www2.dcn.org/orgs/orthophotos/>

¹⁷²

http://www.marinmap.org/Html5Viewer/index.html?viewer=Ortho_Download.Ortho_Download_H5

Geodetic Control

Geodetic control provides a common reference system for establishing coordinates for all geographic data. All NSDI framework data and users' applications data require geodetic control to accurately register spatial data. The National Spatial Reference System is the fundamental geodetic control for the United States.

FGDC provides a "[Geodetic Control Theme Strategic Plan FY17-FY22](#)"¹⁷³ and "[Theme Implementation Plan Geodetic Control NGS](#)"¹⁷⁴ to assist local jurisdictions in implementing the geodetic control theme.

NOAA's National Geodetic Survey (NGS)¹⁷⁵ provides the framework for all positioning activities in the nation and defines, maintains, and provides access to the [National Spatial Reference System \(NSRS\)](#).¹⁷⁶ The NSRS provides a consistent coordinate system that defines latitude, longitude, height, scale, gravity, and orientation throughout the United States and its territories. NGS's [mission](#),¹⁷⁷ [goals](#),¹⁷⁸ and [Ten-Year Strategic Plan](#)¹⁷⁹ are provided on NGS's website. In addition, NGS provides information about [survey marks](#)¹⁸⁰ and [Continuously Operating Reference Station \(CORS\)](#)¹⁸¹ in text datasheets, GIS shapefiles, and a web-based map.^{182, 183} NGS plans to replace NAD 83 (North American Datum) and NAVD 88 (North American Vertical Datum) in 2022.¹⁸⁴ The new reference frames (geometric and geopotential) will rely primarily on Global Navigation Satellite Systems (GNSS) and could be easier and more cost-effective to maintain. However, the new 2022 Datum could cause disruption as well as provide an opportunity for change and for Caltrans to seek additional funding to prepare for the datum change.

The CGIA California Geospatial Framework Draft Data Plan referenced "[Maintaining Geodetic Control for California](#)"¹⁸⁵ on their website. In response to "[Report Card on the U.S. National Spatial Data Infrastructure](#),"¹⁸⁶ the California Geodetic Control Work Group has written a [California Spatial Data Infrastructure Report Card document](#)¹⁸⁷ to provide in-depth detail on the status of the California Geodetic Control Theme. This report card document highlighted the future challenges in sustainable funding for the California Spatial Reference Center and

¹⁷³ https://communities.geoplatform.gov/ngda-geodeticcontrol/wp-content/uploads/2017/12/Geodetic-Control-Theme-Strategic-Plan_FY17-FY22_-20170725.pdf

¹⁷⁴ https://communities.geoplatform.gov/ngda-geodeticcontrol/wp-content/uploads/2017/12/Theme-Implementation-Plan-Geodetic-Control-NGS-20170210-FINAL_withcoverpage.pdf

¹⁷⁵ <https://www.ngs.noaa.gov/>

¹⁷⁶ <https://www.ngs.noaa.gov/INFO/OnePaggers/NSRSOnePager.pdf>

¹⁷⁷ https://www.ngs.noaa.gov/web/news/Ten_Year_Plan_2013-2023.pdf#page=15

¹⁷⁸ https://www.ngs.noaa.gov/web/about_ngo/info/tenyearfinal.shtml

¹⁷⁹ https://www.ngs.noaa.gov/web/news/Ten_Year_Plan_2013-2023.pdf

¹⁸⁰ <https://www.ngs.noaa.gov/datasheets/>

¹⁸¹ <https://www.ngs.noaa.gov/CORS/>

¹⁸² <https://www.ngs.noaa.gov/NGSDataExplorer/>

¹⁸³ https://www.ngs.noaa.gov/CORS_Map/

¹⁸⁴ <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>

¹⁸⁵ <http://cgia.org/cagiscouncil/wp-content/uploads/2018/01/Maintaining-Geodetic-Control-for-California-1-19-18.pdf>

¹⁸⁶ http://www.cogo.pro/uploads/COGO-Report_Card_on_NSDI.pdf

¹⁸⁷ <http://cgia.org/cagiscouncil/wp-content/uploads/2015/04/California-SDI-Report-Card-approved-6-9-16-final.pdf>

discontinuation of funding of the Plate Boundary Observatory (PBO) operated Global Positioning System (GPS) base stations in California.

The [California GIS Council - Geodetic Control Work Group](#)¹⁸⁸ developed a vision, goals, and recommendations for technical enactment, ongoing development, and leadership by appropriate state and local agencies, stakeholders, and partners. This document assesses the current situation and provides a basis for further direction by policy-makers and stakeholders to address the vulnerabilities of California's geodetic control to ensure a sustainable future to meet current and future CSDI needs.¹⁸⁹

According to Caltrans [Project Delivery Quarterly Spring 2016](#),¹⁹⁰ Caltrans North Region Survey Data Center developed a web GIS application called Survey Monument Information Locator and Exporter (SMILE), providing valuable monument data to Surveys field, office, and R/W Engineering staff. Caltrans [Project Delivery Quarterly Spring 2016](#) also provides information about Right of Way and Surveys data available at different Caltrans Districts via Caltrans' intranet. Caltrans OLS organizes geodetic control stations by Caltrans district, then by county, and makes them available in Google Earth Keyhole Markup Layer ([KML files and shapefiles](#)).¹⁹¹

A preliminary Investigation on "[Statewide Real-Time Global Positioning System or Global Navigation Satellite System Network Implementation](#)"¹⁹² was conducted in 2015 at the request of OLS. The [Statewide Real-Time Global Positioning System or Global Navigation Satellite System Network Implementation](#) Preliminary Investigation provided detailed initial funding cost, operation and maintenance cost, and other DOTs' current practice of the statewide GNSS real-time network.

The Caltrans District 6 Surveys website provides [Central Valley Spatial Reference Network \(CVSRN\)](#)¹⁹³ base station information and [San Diego Spatial Reference Network \(SDSRN\)](#).¹⁹⁴ The [California Spatial Reference Center \(CSRC\)](#)¹⁹⁵ is responsible for "Establishing and maintaining an accurate state-of-the-art network of GPS control stations for a reliable spatial reference system in California." The CSRC was established in 1997 as a partnership between surveyors, engineers, GIS professionals, NGS, Caltrans, and the geodetic and geophysical communities. The CSRC is operated by the Scripps Institution of Oceanography.

The [Orange County Real Time Network \(OCRTN\)](#)¹⁹⁶ consists of eleven continuously operating GPS reference stations (CGPS) located in and around Orange County. These CGPS stations are part of the California Spatial Reference System (CSRS) and the California Real Time Network (CRTN). OC has also setup a [Survey Monument Preservation Fund](#).¹⁹⁷

¹⁸⁸ <http://cgia.org/cagiscouncil/workgroups/geodetic-control-workgroup/>

¹⁸⁹ <http://cgia.org/cagiscouncil/wp-content/uploads/2017/12/Maintaining-Geodetic-Control-for-California-11-1-17.pdf>

¹⁹⁰ http://www.dot.ca.gov/hq/projdev/pdq/2016_PDQ_Spring.pdf

¹⁹¹ http://www.dot.ca.gov/hq/row/landsurveys/geodetic/geodetic_control.html

¹⁹²

http://www.dot.ca.gov/newtech/researchreports/preliminary_investigations/docs/real_time_gps_networks_preliminary_investigation.pdf

¹⁹³ <http://www.dot.ca.gov/dist6/surveys/CVSRN/index.htm>

¹⁹⁴ <https://www.sandiegocounty.gov/content/sdc/dpw/surveyor/SDCRTNstatus.html>

¹⁹⁵ <http://csrc.ucsd.edu/>

¹⁹⁶ <http://www.ocpublicworks.com/survey/services/ocrtn>

¹⁹⁷ <http://www.ocpublicworks.com/survey/about/fund>

GPS World magazine created a list of [GNSS reference networks](#)¹⁹⁸ (operated by private and public entities) in the U.S. Many U.S. states operate their own GNSS reference networks.

Ohio DOT (ODOT) owns and operates a [CORS](#)¹⁹⁹ network to perform the role of the reference stations.²⁰⁰ ODOT also provides [survey monument datasheets](#)²⁰¹ on their website.

[MnCORS GNSS Network](#)²⁰² is a cooperative effort between the Minnesota DOT (MnDOT), other state agencies and institutions, counties, cities, and private enterprises with the goal of providing GNSS corrections statewide. MnDOT also provides survey monument data via [Geodetic Monument Viewer](#)²⁰³ and [other formats](#) to the public. More information about Minnesota's geodetic control may be found at [MnGeo's website](#).²⁰⁴

[ODOT survey benchmarks datasheets](#)²⁰⁵ are available online. WSDOT GeoMetrix Geodetic Survey Office's Survey Monument Database, a set of entities and attributes as referenced to individual geographic locations, is available online at <http://www.wsdot.wa.gov/Monument/default.aspx>.

Some California cities and counties, such as [Encinitas](#)²⁰⁶ and [Marin County](#),²⁰⁷ provide survey monument datasheets at their data portal. The author did not search through every California city, county, and MPO for survey monument datasheet availability.

Elevation

FGDC provides an "[Elevation Theme Strategic Plan](#)"²⁰⁸ to assist local jurisdictions in implementing the elevation theme. The USGS National Geospatial Program is developing the [3D Elevation Program](#) (3DEP)²⁰⁹ to respond to growing needs for high-quality topographic data and for a wide range of other three-dimensional (3D) representations of the nation's natural and constructed features. The 3DEP initiative is based on the results of the [National Enhanced Elevation Assessment](#)²¹⁰ that documented more than 600 business uses across 34 federal agencies, all 50 States, selected local government and tribal offices, and private and nonprofit organizations. A fully funded and implemented 3DEP would provide more than \$690 million annually in new benefits to government entities, the private sector, and citizens.²¹¹ [USGS](#)

¹⁹⁸ <http://gpsworld.com/finally-a-list-of-public-rtk-base-stations-in-the-u-s/>

¹⁹⁹ <https://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/Survey/Pages/CORS.aspx>

²⁰⁰ <https://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/Survey/Pages/VRSRTK.aspx>

²⁰¹

<https://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/Survey/Pages/Benchmarks.aspx>

²⁰² <http://www.dot.state.mn.us/surveying/cors/index.html>

²⁰³ <http://mndotgis.dot.state.mn.us/geodetic/Map>

²⁰⁴ <http://www.mngeo.state.mn.us/MSDI/workgroups/geodetic.htm>

²⁰⁵

<https://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/Survey/Pages/Benchmarks.aspx>

²⁰⁶ <http://monumentviewer.encinitasca.gov/>

²⁰⁷

https://www.marinmap.org/Html5Viewer/index.html?viewer=Benchmark_child.BenchMark_H5

²⁰⁸ <https://communities.geoplatform.gov/ngda-elevation/wp-content/uploads/2017/12/elevation-theme-SP-draft-09262016-clean.pdf>

²⁰⁹ <https://nationalmap.gov/3DEP/>

²¹⁰ <https://nationalmap.gov/3DEP/nea.html>

²¹¹ <https://communities.geoplatform.gov/ngda-elevation/3dep-adata-acquisition/>

National Enhanced Elevation Assessment report²¹² was published in 2012. The USGS 1-meter Digital Elevation Models (DEMs) - USGS National Map 3DEP²¹³ is available for download at catalog.data.gov.

OpenTopography,²¹⁴ a National Science Foundation (NSF) data facility, hosts and distributes NSF-funded aerial LiDAR datasets.²¹⁵ Many of OpenTopography's open LiDAR datasets cover the California coast. OC provides their aerial LiDAR²¹⁶ via arcgis.com.

Caltrans highway elevation data²¹⁷ was collected using the Caltrans Office of Pavement Management²¹⁸ Automated Pavement Condition Survey (APCS), which uses a customized vehicle fitted with sensing equipment traveling on the roadway at or near highway speeds to collect pavement condition data as well as other useful information, such as elevation, longitude, latitude, etc.²¹⁹

The Indiana Geological and Water Survey (IGWS)²²⁰ was established in Indiana State in 1993 as an institution of Indiana University to provide unbiased and reliable earth science information through directed research, service, and education. Indiana University hosts Indiana Elevation 3D (2011 - 2013).²²¹ This 3D elevation layer was created by personnel of the Indiana Geological Survey from the Indiana 1.5-m DEMs collected from 2011 to 2013.

The 3D Geomatics Committee of the Minnesota Geospatial Advisory Council²²² works to identify and promote the need for planning, funding, acquisition, and management of 3D geomatic data (including elevation data) and derived products. The Minnesota Elevation Mapping Project,²²³ funded in 2009, developed and delivered a high-accuracy digital elevation map of the State of Minnesota, based on data collected using LiDAR technology.

MnGeo provides their elevation data via:

- MnTOPO,²²⁴ a web application for viewing, printing, and downloading high-resolution elevation data for Minnesota collected using LiDAR technology, and
- LiDAR info and download page²²⁵ for Minnesota LiDAR data and derived products, including links to education and training resources.

²¹² http://www.dewberry.com/docs/default-source/documents/needa_final-report_revised-3-29-12.pdf?sfvrsn=0

²¹³ <https://catalog.data.gov/dataset/usgs-national-elevation-dataset-1-meter-downloadable-data-collection-from-the-national-map>

²¹⁴ <http://www.opentopography.org/>

²¹⁵ <http://opentopo.sdsc.edu/datasets>

²¹⁶

<http://ocpw.maps.arcgis.com/apps/webappviewer/index.html?id=a7151892d7774656b095f493c34bac4e>

²¹⁷ <http://www.dot.ca.gov/hq/tsip/gis/datalibrary/zip/Boundaries/Elevation2016APCS.zip>

²¹⁸ http://dot.ca.gov/hq/maint/Pavement/Offices/Pavement_Management/index.html

²¹⁹ <http://www.dot.ca.gov/hq/tsip/gis/datalibrary/Metadata/Elevation.html>

²²⁰ <https://igws.indiana.edu/About/>

²²¹

http://maps.indiana.edu/arcgis/rest/services/ImageService/LiDAR_DEM_Elevation_IN/ImageServer

²²² <http://www.mngeo.state.mn.us/committee/3dgeo/index.html>

²²³ http://www.mngeo.state.mn.us/committee/elevation/mn_elev_mapping.html

²²⁴ <http://www.dnr.state.mn.us/maps/mntopo/index.html>

²²⁵ <http://www.mngeo.state.mn.us/chouse/elevation/lidar.html>

NSDI Strategic Plan, Charter, and Funding

The [NSDI Cooperative Agreements Program \(CAP\)](#)²²⁶ was an annual program to assist the geospatial data community through funding and other resources in implementing the components of the NSDI. The program provided small seed grants to initiate sustainable on-going NSDI implementations and emphasized partnerships, collaboration, and the leveraging of geospatial resources in achieving its goals. Even though CAP has ended, a similar grant program may be available in the future from the federal government such as [FHWA Every Day Counts](#),²²⁷ [FHWA Highway for LIFE](#),²²⁸ and [USGS Financial Assistance Programs](#).²²⁹ [FDOT's 2011 NSDI CAP grant application](#)²³⁰ is available online.

The [Missouri I-Team Plan](#)²³¹ is an NSDI theme implementation plan for Missouri.

[Charter Document: Florida Statewide Coordination of Terrestrial Orthophotography](#)²³² and [Florida Statewide Coordination of Terrestrial Orthophotography](#)²³³ are available at the Florida St. Johns River Water Management District website.

Related Research and Resources

GIS Standards, Strategic Plan, and Implementation Plan

A NSDI theme implementation is often coordinated by or carried out by a state's GIS body. The State's GIS Strategic and Implementation Plan often covers NSDI themes. Caltrans [GIS Standards and Technology Implementation PI](#)²³⁴ listed many U.S. State's GIS Strategic and Implementation Plans. The GIS Strategic Plan for the [U.S. Department of Transportation](#)²³⁵ includes discussion of incorporating NSDI and using GIS to solve business needs analysis.

Data Governance

GIS strategic plans often contain GIS governance and policy details for their organizations. In some cases, the GIS governance and data policy are covered under the general data governance and data policy of the state-level IT or CIO. GIS strategic plans and GIS governance and data policies differ due to differences in organizational structure. Some U.S. states address NSDI theme implementation under the "Data Governance" umbrella.

²²⁶ <https://www.fgdc.gov/grants/2011CAP/2011CAPDescriptions>

²²⁷ <https://www.fhwa.dot.gov/innovation/everydaycounts/>

²²⁸ <https://www.fhwa.dot.gov/hfl/>

²²⁹ <https://www2.usgs.gov/contracts/faprograms.html>

²³⁰

http://open.sjrwmd.com/FloridaOrthoCoordination/documents/2011_cap_florida_application_narrative_FINAL.pdf

²³¹ <https://www.mgisac.org/uploads/DataDevelopment/i-team-plan-march03.pdf>

²³² <http://open.sjrwmd.com/FloridaOrthoCoordination/documents/OrthoCoordinationCharter.pdf>

²³³ <http://open.sjrwmd.com/FloridaOrthoCoordination/documents/OrthoCoordinationRoles.pdf>

²³⁴

http://www.dot.ca.gov/newtech/researchreports/preliminary_investigations/docs/gis_standards_pi.pdf

²³⁵ https://cms.dot.gov/sites/dot.gov/files/docs/GISStrategicPlan_0831_final.pdf

The [Georgia Spatial Data Infrastructure](#) (GaSDI),²³⁶ hosted by the Georgia Institute of Technology and the University of Georgia, has an online [document library](#)²³⁷ containing GIS related documents and [presentations](#).²³⁸

Minnesota Data Plans and Policies:

- [Free and Open Data](#):²³⁹ The MetroGIS Data Producers Work Group and Policy Board provides a webpage of resource materials, research, articles, status map, county policy resolutions, and presentations.
- [Minnesota State GIS Enterprise Conceptual Architecture Design](#),²⁴⁰ March 2005: This document defines a high-level architecture for information technology and web-mapping interoperability in support of the goals outlined in the state's strategic plan for GIS, the Minnesota Spatial Data Infrastructure. The structural design proposed would promote interoperability among GIS data and application providers, increasing efficiency and reducing long-term costs in data resource and software application development.
- [A Foundation for Coordinated GIS, Minnesota's Spatial Data Infrastructure](#),²⁴¹ October 20, 2004: Adopted by the Minnesota Governor's Council on Geographic Information, this is a strategic plan to help Minnesota organizations more effectively achieve their business goals by using GIS.
- [Guidebook to Priority GIS Data](#),²⁴² July 1999: A report by the Governor's Council on Geographic Information that describes the status and availability of eleven key digital data themes.

[NextGen 911](#)²⁴³ relies on accurate cadastral data. Collaboration with NextGen 911 may eliminate duplication of effort.

Arizona State University researcher Gene Trobia, the former cartographer for the state of Arizona, explained what framework data layers are and how they are changing the game for state governments.^{244 245}

Oregon GIO Cy Smith explained the value and importance of GIO in state government in a podcast.²⁴⁶

Gaps in Findings

A comprehensive literature search failed to identify commonly shared NSDI strategic and implementation plans or governance policies due to the diverse organizational nature of state government agencies. Many State, State DOT, and local agency GIS practitioners have posted their NSDI theme data online via a web-based map and/or shpfiles and/or geodatabases. FGDC

²³⁶ <https://www.georgiaspatial.org/home>

²³⁷ <https://www.georgiaspatial.org/technical-documents/all>

²³⁸ <https://www.georgiaspatial.org/presentations/11>

²³⁹ <https://www.metrogis.org/projects/free-open-data.aspx>

²⁴⁰

<http://www.mngeo.state.mn.us/committee/standards/MNGISConceptualArchitectureDesign.pdf>

²⁴¹ http://www.mngeo.state.mn.us/pdf/MN_IPlan_Consolidation_Final_04OCT13.pdf

²⁴² http://www.mngeo.state.mn.us/pdf/priority_gis_data_July1999.pdf

²⁴³ https://www.911.gov/issue_nextgeneration911.html

²⁴⁴ <https://statescoop.com/states-look-to-framework-data-layers-to-standardize-gis-efforts>

²⁴⁵ <https://soundcloud.com/statescoop/gis-addressed-episode-2-framework-data-layers>

²⁴⁶ <https://soundcloud.com/statescoop/gis-addressed-episode-1-value-of-the-gio>

provides extensive details and documents, addressing the What, Why, Who, ROI, and to certain extent How, of NSDI in order to assist local jurisdictions for NSDI implementation.

Funding and staffing information for NSDI implementation and maintenance not generally available online. Funding and staffing present the most significant challenges. For example, GaSDI funding was discontinued and their service level is at minimum (Georgia Institute of Technology and the University of Georgia provide continued operation of GaSDI website). FGDC CAP grants have kick-started a few State's NSDI programs. However, each State has to figure out how to establish a sustainable program to implement and maintain NSDI theme data. Some States have partnerships with universities to share cost and workload.

Some existing Caltrans resources are not easy to find or only available within Caltrans' private intranet. Caltrans uses Caltrans Earth, a licensed version of Google Earth, to provide its GIS data internally and externally. Google Earth is being deprecated by Google. A different web-based map engine is need to distribute Caltrans' GIS data in the near future. Arcgis.com and giscloud.com are used by many State DOT and local counties.

Next Steps

Strategic Steps for NSDI Implementation and Maintenance

1. Adopt recommendations and implement in FHWA Every Day Counts Round 2 Geospatial Data Collaboration Initiative Recommendations to Improve Caltrans Geospatial Data Collaboration report.
2. The concept of Orange County's Survey Monument Preservation Fund may be used to cover for NSDI theme ongoing maintenance cost.
3. Collaborations with local jurisdictions could yield richer datasets. Datasets from local cities, counties, and MPOs, data can supplement Caltrans' needs. States with extensive GIS data have partnerships and/or collaboration with local agencies and universities.
4. Review other DOTs' and other public agencies' NSDI implementation plan documents.
5. Look for federal grants.
6. Develop a NSDI Implementation and Maintenance Plan.
 - a. Develop roles and responsibilities for NSDI themes.
 - b. Develop a data dictionary for NSDI themes.
 - c. Adopt data governance policy and guideline standards.
 - d. Teach and communicate with GIS stakeholders (IT, data providers, and data consumers).
 - e. Establish a data portal for all Caltrans' data and GIS documents on policies, standards, and plans.
7. GIS Data should be made available in shpfiles or geodatabase for advanced GIS analysis, a web-based map for novice or public viewers, and Application Program Interface (API) for software developers.

Detailed Findings

Consultation with State DOTs and Other State Agencies

A survey of other transportation and local agencies' current NSDI Implementation was conducted. This survey was sent by AHMCT to a contact list (see Contacts section below) provided by Caltrans. The questionnaire is provided here for reference and the questions are omitted in the results section.

1. Please provide your contact information:

Name:

Job title:

Organization:

Email:

Phone Number:

2. Does your organization have defined sets of NSDI core framework data for RWLS? If so, what are they?
3. Does your organization have state specific SDI datasets considered core for RWLS that are not listed above? If so, what are they (please include under "Other" below)?
4. What RWLS related NSDI/state specific SDI core data do you purchase from commercial vendors? Please provide vendor name(s) if available.

NSDI Core Data	Answer (No, Yes, or Vendor's Name)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

- a. Do you add value to vendor data by blending it with data created in house?

NSDI Core Data	Answer (No, yes, or do not know)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

5. What RWLS related NSDI/state specific SDI core datasets do you produce and maintain with in-house resources?

NSDI Core Data	Answer (No, yes, or do not know)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

6. What RWLS related NSDI/state specific SDI core data is obtained through a consortium of stakeholders?

NSDI Core Data	Answer (No, yes, or do not know)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

- a. How is consortium data maintained?

NSDI Core Data	Answer
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

7. Do you work with university partners to create or obtain RWLS related NSDI/state specific SDI core data?

NSDI Core Data	Answer (No, yes, or do not know)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

8. Do you store RWLS related NSDI/state specific SDI core data on premises or in the cloud? Are you using a hybrid cloud approach? With what results?

NSDI Core Data	Answer (In Cloud, on premises, or do not know)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

9. Do you maintain and provide past versions of data (e.g. imagery older than current)?

NSDI Core Data	Answer (No, yes, or do not know)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

10. What systems do you use to deliver RWLS related NSDI/state specific SDI core data?

NSDI Core Data	Answer
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

a. Do you offer Open Geospatial Consortium compliant web feature services of RWLS related NSDI/state specific SDI core data?

NSDI Core Data	Answer (No, yes, or do not know)
Geodetic Control	
Cadastral (Parcels)	
Elevation	
Ortho Imagery	
Other	

11. What clients use your organization's related NSDI/state specific SDI core data? Do they share in the cost of the data?

NSDI Core Data	Answer (No, clients' name, or do not know)	Cost sharing? (yes, no, do not know)
Geodetic Control		
Cadastral (Parcels)		
Elevation		
Ortho Imagery		
Other		

12. What commercially available RWLS related NSDI/ state specific SDI core dataset(s) do you lack access to? What is the reason for lack of access?

NSDI Core Data	Answer (No, yes, or do not know)	Why?
Geodetic Control		
Cadastral (Parcels)		
Elevation		
Ortho Imagery		
Other		

Survey Responses

Arizona DOT (AZDOT), Arkansas DOT (ARDOT), Connecticut DOT (CTDOT), Minnesota DOT (MNDOT), South Dakota DOT (SDDOT), Wisconsin DOT (WisDOT), and Wyoming DOT (WYDOT) responded to the survey questionnaire. The below questionnaire responses were received.

DOT	Question 2: Does your organization have defined sets of NSDI core framework data for RWLS? If so, what are they?
AZDOT	Yes, NAD83/92 Horizontal & NAVD88 Vertical
ARDOT	No
CTDOT	No, we find NSDI standards too cumbersome and not very cost efficient to formally implement at this time.
MNDOT	This is true for Geodetic Control, Orthomosaics and Elevation data. However, our Parcel data are unique to our projects and therefore are not always complete. I.e., all we show is the partial parcel as it intersects our R/W line and the total parent parcel. So if a parent parcel is made up of more than two minor parcels and those lines are outside of the R/W line, some of the minor lines are often not shown.
SDDOT	No
WisDOT	No
WYDOT	No

DOT	Question 3: Does your organization have state specific SDI datasets considered core for RWLS that are not listed above? If so, what are they (please include under "Other" below)?
AZDOT	Yes, Per Plans
ARDOT	Not Available (N/A)
CTDOT	Not really, our Geodetic Unit does for control, but basically only the data that gets shared out to NGS meets the suggested standards.
MNDOT	Only unique to the DOT and not local transportation agencies.
SDDOT	No
WisDOT	No
WYDOT	N/A

Question 4: What RWLS related NSDI/state specific SDI core data do you purchase from commercial vendors? Please provide vendor name(s) if available.

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	No	No	No	Yes, Development On-Call through Engineering Consultants Section	N/A
ARDOT	No	No	No	No	N/A
CTDOT	No	No	No	Yes - Various	Conventional photogrammetry. LiDAR (aerial, mobile, and stationary)
MNDOT	None	None	None	None	No – Geological map data is handled by the Minn. Geological Survey.
SDDOT	No	No	No	Fugro Geospatial	N/A
WisDOT	None	None	None	None	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 4a: Do you add value to vendor data by blending it with data created in house?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	No	No	No	No	N/A
ARDOT	No	No	No	No	N/A
CTDOT	No	No	No	Yes	Yes (Conventional Photogrammetry. LiDAR (aerial, mobile and stationary))
MNDOT	Yes, we use ESRI data as a background for our data.	Yes, we use ESRI data as a background for our data.	Yes, we use ESRI data as a background for our data.	No, not in this case.	N/A
SDDOT	No	No	No	No	N/A
WisDOT	N/A	N/A	N/A	N/A	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 5: What RWLS related NSDI/state specific SDI core datasets do you produce and maintain with in-house resources?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	Yes	Yes	Yes	Yes	N/A
ARDOT	Yes	Yes, project specific, no statewide layer.	Yes	Yes	N/A
CTDOT	Yes	Yes	Both	Both	N/A
MNDOT	Yes, MnDOT houses a Geodetic Unit that works with NGS and supports a statewide CORS and passive control mark system. They also work with the counties to produce a local passive mark system at a 3-mile spacing interval. This is also submitted to NGS for inclusion into their database. Eighty of the eighty-six counties are complete.	Parcel data is produced at the corridor, project level. Maps and plats are produced to fulfil specific requirements. We are working on trying to supplement our Right Of Way Information System (ROWIS) so that documents can be retrieved geospatially instead of by text input.	The state does not own equipment (planes or sensors) to do the collection for this work. It is contracted for by the state's procurement method (RFP or direct select). Elevation data is required for the design process but is often not collected or produced as part of the As-built process.	The state does not own equipment (planes or sensors) to do the collection for this work. It is contracted for by the state's procurement method (RFP or direct select). Elevation data is required for the design process but is often not collected or produced as part of the As-built process.	N/A
SDDOT	No	No	No	No	N/A
WisDOT	No	No	Yes	Yes	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 6: What RWLS related NSDI/state specific SDI core data is obtained through a consortium of stakeholders?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	Yes	Yes	Yes	Yes	N/A
ARDOT	No	No	No	No	N/A
CTDOT	No	Yes	Yes	Yes	N/A
MNDOT	None	None	We have a publicly available statewide LiDAR dataset collected between 2008-2011. Multiple vendors produced this data. We are in the planning stages for a second collect. This is used specifically for planning activities, once a project has been selected and included in one of the legislative mandated planning tools it is eligible for state funding and then accurate mapping can begin.	We have a publicly available statewide ortho dataset collected between 2010-2014. Multiple vendors produced this data. We are not planning for another at this time. The same planning/mapping requirements apply here as well.	N/A
SDDOT	No	No	No	No	N/A
WisDOT	Yes	Yes	Yes	Yes	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 6a: How is consortium data maintained?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	Cloud Based Server	Cloud Based Server	Cloud Based Server	We are reviewing our options since the datasets are so large.	N/A
ARDOT	N/A	N/A	N/A	N/A	N/A
CTDOT	In-House and Shared with NGS	Various means	Various means	Various means	N/A
MNDOT	MnDOT maintained	MnDOT maintained	Through the MnGeo data warehouse	Through the MnGeo data warehouse	N/A
SDDOT	N/A	N/A	N/A	N/A	N/A
WisDOT	By others	By others	By others	By others	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 7: Do you work with university partners to create or obtain RWLS related NSDI/state specific SDI core data?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	No	No	No	No	N/A
ARDOT	No	No	No	No	N/A
CTDOT	Yes	No	Yes	No	N/A
MNDOT	No, except for research related projects.	No	No	No	N/A
SDDOT	No	No	No	No	N/A
WisDOT	Yes	No	Yes	Yes	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 8: Do you store RWLS related NSDI/state specific SDI core data on premises or in the cloud? Are you using a hybrid cloud approach? With what results?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	On Web with NGS and Cloud	On Web with NGS and Cloud	On Web with NGS and Cloud	We are reviewing our options since the datasets are so large.	N/A
ARDOT	On premises	On premises	On premises	On premises	N/A
CTDOT	On premises	Do not know	All	All	N/A
MNDOT	On Premises	On Premises	Through the MnGeo data warehouse, the cloud is being investigated and a contract has been established but no data from our office has been submitted to the cloud.	Through the MnGeo data warehouse, the cloud is being investigated and a contract has been established but no data from our office has been submitted to the cloud.	N/A
SDDOT	On premises	On premises	On premises	On premises	N/A
WisDOT	On premises	On premises	On premises	On premises	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 9: Do you maintain and provide past versions of data (e.g. imagery older than current)?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	Yes	Yes	Yes	Yes	N/A
ARDOT	Yes	No	Yes	Yes	N/A
CTDOT	Yes	Yes	Yes	Yes	N/A
MNDOT	Yes	Yes	Not digitally	Yes	N/A
SDDOT	No	No	No	No	N/A
WisDOT	Yes	Yes	Yes	Yes	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 10: What systems do you use to deliver RWLS related NSDI/state specific SDI core data?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	MS Excel file through e-mail.	MS Excel file through e-mail.	MS Excel file through e-mail.	External hard drive – Only available upon request.	N/A
ARDOT	Access database available from ARDOT website	Plats are available for download from State Surveyors office	Access database available from ARDOT website	CD or FTP site for requested files	N/A
CTDOT	N/A	N/A	N/A	N/A	N/A
MNDOT	Our Geodetic Database with external access from MNDOT website.	Through a viewer and only to internal clients at this time.	The MnGeo site.	The MnGeo site.	N/A
SDDOT	No	No	No		N/A
WisDOT	Electronical / FTP / Email / Hard Copy	Electronical / FTP / Email / Hard Copy	In-house server for storage data / Email	In-house server for storage data / Email	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 10a: Do you offer Open Geospatial Consortium compliant web feature services of RWLS related NSDI/state specific SDI core data?

NSDI Core / DOT	Geodetic Control	Cadastral (Parcels)	Elevation	Ortho Imagery	Other
AZDOT	No	No	No	No	N/A
ARDOT	No	No	No	No	N/A
CTDOT	No	Do not know	No	Do not know	N/A
MNDOT	Yes	No	Yes	Yes	N/A
SDDOT	No	No	No	No	N/A
WisDOT	Yes	No	No	No	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A

Question 11: What clients use your organization's related NSDI/state specific SDI core data? Do they share in the cost of the data?

NSDI Core	Geodetic Control		Cadastral (Parcels)		Elevation		Ortho Imagery		Other
	Clients	Cost Sharing	Clients	Cost Sharing	Clients	Cost Sharing	Clients	Cost Sharing	
DOT	Yes	Multiple	Yes	Multiple	Yes	Multiple	No	N/A	Joint Project Agreement Section drafts up an agreement between ADOT and "John Q Whomever" to allow them to provide either GNSS receivers or a hosting site with power/internet.
ARDOT	Private surveyors Public data	N/A	Private surveyors Public data	N/A	Private surveyors Public data	N/A	N/A	N/A	N/A
CTDOT	Public data	Taxes	Public data	Taxes	Public data	Taxes	Public data	N/A	N/A

MNDOT	Sister agencies, counties, cities and private sector clients all use our site.	No, DOT currently pays for this.	Internal clients are the only users at this time.	No	Internal clients mostly but some external clients call for data because they are developing adjacent to our highway.	No, all data is free.	Same as above.	No, all data is free.	N/A
SDDOT	No	No	N/A	No	No	N/A	No	N/A	N/A
WisDOT	Government, engineers, scientists, surveyors, construction industry, GIS users, agricultural users and academia.	No	WisDOT staff design engineers, others.	WisDOT project funding pays for data.	WisDOT staff design engineers, others.	WisDOT project funding pays for data.	WisDOT staff design engineers, others.	WisDOT project funding pays for data.	N/A
WYDOT		N/A		N/A	N/A	N/A	N/A	N/A	N/A

Question 12: What commercially available RWLS related NSDI/ state specific SDI core dataset(s) do you lack access to? What is the reason for lack of access?

NSDI Core	Geodetic Control		Cadastral (Parcels)		Elevation		Ortho Imagery		Other
	DOT	Why	DOT	Why	DOT	Why	DOT	Why	
AZDOT	Do not know.	N/A	Do not know.	N/A	Do not know.	N/A	Do not know.	N/A	Do not know if alternatives are available or associated costs.
ARDOT	No	N/A	No	N/A	No	N/A	No	N/A	N/A
CTDOT	No	N/A	No	Some towns have no public GIS	No	N/A	No	N/A	N/A
MNDOT	No	N/A	No	N/A	No	N/A	No	N/A	N/A
SDDOT	No	No	N/A	No	No	N/A	No	N/A	N/A
WisDOT	None	N/A	None	N/A	None	N/A	None	N/A	N/A
WYDOT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Additional Comments

CTDOT

“Here in CT, we don’t have a formal statewide or even DOT-wide GIS (at least not Enterprise-Wide). More recently, my agency has made some great strides to that means so data standardization efforts have begun. I envision that as data stewardship and standardization is embraced across our enterprise that NSDI standards will be the default. As far as cadastral data goes, our DOT-controlled parcel data is well organized, but metadata is available only via research into project level formats and not tabular.”

WYDOT

“We don't have such a database so the first to questions are no and the rest don't need to be answered. What did make me wonder however is the idea of obtaining professional service item by purchase or off the web. Is that what you are looking to move toward? Some sort of design and survey by records in databases?”

Contacts

The following individuals responded to the survey questionnaire.

Arizona

Virgil C Coxon
Survey Manager
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