Washington State Cadastre: Integrating Topology, Aquatic Ownership, and Land Records

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Abstract

The Washington Department of Natural Resources (DNR) implemented Cadastral Geodatabase layers for corners, boundaries, legal descriptions, state ownership parcels, and administrative jurisdictions in 2002. Since then, the DNR has expanded the scope of the project by adopting topology rules and editing, converting Aquatic Land Ownership coverage data to the upland Geodatabase, and developing a land records document system and interfacing that Automated Tract Book (ATB) system with the Geodatabase. The change to topology required conceptual changes in the editing process, and physical changes in the process to backload the legacy public land survey, ownership, and administration coverage. Minor changes and extensions of the cadastral data model enabled inclusion of aquatic ownership despite topology rule differences between aquatic and upland ownership. Finally, a process was developed to push parcel data into the ATB land records document system, and pull parcel document and grantor/grantee data into the Geodatabase.

Introduction

The Washington Department of Natural Resources (DNR) manages 2 million acres of uplands and 3 million acres of aquatic lands held in trust for schools, universities, the capitol, counties, and the public. The DNR has been using Environmental Systems Research Institute's (ESRI) Arc/Info to manage these lands since 1985. The public land survey, ownership, county, and administration (POCA) (DNR, 2002), and public land survey points (PLS-PT) coverages have been the repository for managing land survey and ownership data. However, the land managers using the information, and the land surveyors maintaining the coverages were interested in extending the usefulness of the information. Some revisions have taken place over the years, but a decision to redesign the layers to support more effective land management practices was made in 1996.

Background: Cadastral Project

The Cadastral Framework project began by adopting the Federal Geographic Data Committee's (FGDC) Cadastral Data Content Standard (FGDC, 1996). Modifications were made to the data model to accommodate the existing DNR data, and Spatial Database Engine (SDE) layers were built and loaded with data in the first phase of the Washington Cadastral Framework Project (Wolfe, 1998). In the second phase of the project, the data was made publicly accessible over the Internet using ArcView Internet Map Server (IMS) and a data transfer standard was created to allow partners to contribute data to the Framework database. Several partners, the Bureau of Land Management, Snohomish County, and Longview Fibre Company, contributed data and participated in testing the process. (Tudor, 2000.)

Maintenance of the data was still problematic since the data had to be checked out to coverages and back in to SDE. In 1998, information was gathered about possible alternatives to moving the data in and out of coverages or using incomplete ArcView editing extensions. In 1999, ESRI together with partner NovaLIS was the only respondent to the DNR's request for proposals. The DNR was encouraged to participate in the National Integrated Land System (NILS) being developed jointly by the United States Bureau of Land Management, Forest Service, and ESRI (BLM, 2003). After working as a NILS partner for a year, DNR managers decided to refocus internally on explicit DNR needs.

The DNR developed a service contract with ESRI Northwest to implement the SDE database as a Geodatabase (GDB) and build editing tools that would support typical maintenance operations. One of the primary goals of the contract was to ensure that the cadastral GDB would be compatible with new releases of ArcGIS that would include topology and creation of business rules. In 2002, the DNR implemented the Cadastral Geodatabase as its first production transactional Geodatabase using Visio CASE (Tudor, 2002). Because its implementation was ahead of the rest of the agency, a process to backload data to the original POCA and PLS-PT coverages was implemented to support remaining legacy applications. While this has worked well, the effort was tremendous, and the future transition from Arc/Info coverages to ArcGIS feature classes will be one way with few exceptions. The plan for DNR's ArcGIS migration is to convert covers to Geodatabase layers, develop application map and report output to access the GDB, turn off coverage based output, develop edit applications to work with GDB layers, and turn off coverage edit applications.

The Cadastral Geodatabase includes several layers: Parcel as the basic unit of land transactions such as ownership, easements, leases, and permits; Jurisdiction as the areas of administrative authority and management policy; Legal Description as the extent of land defined through legal and surveying processes; Boundaries as the edges of Legal Descriptions and Jurisdictions; and Points as corners anchoring boundaries and control defining measured locations. (Tudor, 1999.)

The focus of this paper is the extension of the Cadastral application to work with newer ESRI topology technology, and extension of the Cadastral Geodatabase to carry Aquatic Land Ownership features, and Land Title Office documents. It should be noted that although the original design of the Cadastral Geodatabase included incorporation of Land Title and Aquatic Land Ownership data, these were not implemented until this phase and significant modifications were made in the design.

Implementing Topology

As the Cadastral Geodatabase was going into production, ESRI released Topology as part of the ArcGIS 8.3 software. The DNR was very excited about topology as a means of enforcing spatial integrity, and DNR and ESRI NW spent time in advance of implementation developing topology rules and feature subclasses. Until that time, the DNR had been using the Shared Edit Tool. Tiny slivers from the editing process would have to be cleaned up manually at high magnification. DNR staff began using the Topology Editor, and was initially concerned that there were still tiny slivers. However, after the first topology validation, the slivers cleared up, leaving actual rule violations to be fixed or accepted as exceptions to the rules.

The validation cleans the data within the Cluster Tolerance and flags rule violations larger than that tolerance. The Cluster Tolerance for a topology rule set determines how much a feature will move to overcome a rule violation. This is something like a fuzzy tolerance in Workstation Arc/Info. However, there is no fuzzy creep because the integer-based coordinates of the Geodatabase do not let the location float. Once the features that interact with each other have settled in the first validation and correction, the location does not move with subsequent topology validation unless a new feature falls within the tolerance and gets included in the interaction. To ensure that the movement is minimal, the Cluster Tolerance for the upland and aquatic topologies are set to 0.01 feet.

The DNR implemented a small set of topology rules for the upland layers at first, but the topology rules have been growing steadily and currently include 43 upland rules and 7 aquatic rules in a new aquatic topology. Some typical rules are Boundary must not have dangles, Legal Description must not have gaps, Parcel:Ownership must not overlap, Jurisdiction:State must be covered by Jurisdiction:County. Some rules pertain to just one feature class; most include two feature classes. Feature subclasses or subtypes can also be included, such as Jurisdiction:State. After implementation, the tessellate topology rule provided by ESRI became unavailable and was replaced by applying both topology rules: “must not overlap” and “must be covered by feature class of”. (See the complete list of current Cadastral GDB topology rules in the Appendix.)

There is also a rule ranking that determines which rules are applied first. The more highly ranked feature classes are not affected by features ranked lower. In the upland topology the ranking is 1-Point, 2-Boundary, 3-Legal Description, 4-Parcel, and 5-Jurisdiction. So, Point features do not move when there is a rule violation including Point and some other feature class. In the aquatic topology implemented later, the ranking is 1-Aquatic_Boundary, and 2-Aquatic_Parcel. (ESRI, 2003.)

Background: Aquatic Land Ownership Project

The state aquatic lands managed by the DNR have been recorded on a set of maps known as the Marine Plates since statehood in 1889. The Marine Plates cover the entire shoreline of Washington State covering 4,000 lineal miles of tideland and shoreland. All records of sales and leases have been drafted by hand to show location on the plates and entered in a tabular form as margin notes. These maps contain the only index to approximately 30,000 tideland and shoreland deeds, and to current and historical leases on state-owned aquatic lands, and the maps are deteriorating with use and age. The maps themselves are so poorly indexed that is difficult to be sure that all necessary information is found for managing the land. The Marine Plates are large, bulky, heavy bound volumes and not easily available to land managers who need the information. The information on the plates in paper form is not readily integrated with upland ownership and environmental information on the agency’s

GIS.

The Aquatic Land Ownership project began in 1994 to preserve the Marine Plates and make them more accessible for land management activities by bringing them into the agency's GIS. The maps were to be comprehensively indexed, scanned, spatially registered, vectorized, loaded into a set of GIS arc and polygon coverages tiled by county, and attributed. After a pilot project in Whatcom County in 1995, all Marine Plates were scanned, registered, and vectorized through a contract with ValueCad by 1998. All county coverages for the state were loaded and attributed by 2001. An interim application was developed to help maintain critical data, but a regular program of maintenance was not followed. At nearly the same time in 1999, the Cadastral Project embraced the Aquatic Resources Division's requirements as the data model for the Cadastral Geodatabase was being redesigned. As the successes of the upland Cadastral Project became stronger, interest in integrating the Aquatic Land Ownership coverages into the Cadastral Geodatabase grew, and in 2002, work on integration began.

Converting ALO and Adjusting for Topology

The Cadastral Geodatabase had been designed to include Aquatic Land Ownership data from the beginning. The ALO data model was brought to design meetings and Aquatic Resources staff members were included in design discussions. So the expectations were that ALO data would fit easily into the Cadastral GDB. As the ALO data conversion drew near, an initial data conversion matrix was developed matching the legacy aquatic Arc/Info data to the Cadastral Geodatabase data model. The conversion matrix was then discussed line by line in teamwork sessions. These sessions proved to be crucial timesavers later in the project. Several data items had exceptions that were difficult even for the data stewards to resolve. While there were issues that were not totally resolved up front, the vast majority of matrix issues were defined during these long detailed meetings.

The existing Cadastre data model was also assessed for the ability to accommodate the aquatic parcel requirements. The Cadastre model consisted of five Oracle/Geodatabase tables: Point, Boundary, Legal_Description, Parcel, and Jurisdiction. There was no aquatic point data to be loaded. Boundary would move straight across. While the legacy aquatic data had spatial features for Boundary and Parcel, the attributes seemed to span logically into Legal_Description and Jurisdiction as well. In fact, by definition, the aquatic legal descriptions, lacking PLS descriptions, were the same as the parcel. Likewise, some of the aquatic parcels also represented jurisdictions. As a result, the single Arc/Info table of aquatic parcel data was initially planned for loading into all three - Legal_Description, Parcel, and Jurisdiction.

Most of the required columns already existed in the Cadastre model however there were several columns that were added. Most of the aquatic attributes had been anticipated during the original Cadastre design. Some of those were used while others were modified based on more in depth discussion. Among the existing columns, domains often needed additional values to accommodate the aquatic data.

The main difficulty of the data conversion process was related to the fact that the single Parcel Arc/Info data source was being loaded into three tables, two of which, Parcel and Legal_Description had many-to-many relationships to each other. This meant that the primary keys for these tables had to be created and loaded correctly into the associative join tables. To solve this problem, a large conversion table was created that had the columns from the legacy Arc/Info system as well as all of the columns from the Parcel, Legal_Description, and Jurisdiction tables. Then the spatial and attribute data was loaded into the conversion table using the SDE administration command cov2sde. SQL scripts were run in Oracle to populate the remaining conversion table columns matching the Cadastre tables according to the conversion rules from the matrix spreadsheet. The conversion table, fully loaded, held all of the spatial data, the legacy columns, and the Cadastre columns from three destination tables all in one table. Finally, the new primary keys for the Parcel, Legal_Description tables were set in the conversion table. Now it was fully prepared for the transfer into the Cadastral Geodatabase.

The data was extracted from the conversion table into three separate shape files using sde2shp from the command line and loaded into the Cadastre tables using shp2sde. All that was left at that point was to populate the relationships in the associative Cadastre table from the conversion table using SQL. The associative table, Parcel_Legal_Description, held the relationship between Parcel and Legal_Description. This table was necessary because in the uplands model the relationships were many-to-many. Because of the single data source of the legacy aquatic parcel data, the new aquatic rows in Cadastre were actually one-to-one. Additionally, the same aquatic polygons were loaded into both tables, since they were both Parcel and Legal_Description data. Once the data was loaded ArcCatalog was used to verify and administer the data.

For reporting and web access, the new Aquatic Land Ownership and Automated Tract Book layers and tables were added to a data mart called ROPA (Read Only Production Access). ROPA is a separate Enterprise Geodatabase in Oracle modeled specifically for optimized read-only access. With the addition of aquatic data, an aquatic ROPA data model was developed. It was decided that because performance was critical for the success of the Aquatic ROPA system, that unlike the Cadastre Geodatabase, the data mart would separate aquatic from uplands data. New tables were modeled for the aquatic boundary and parcel data as Aquatic_Boundary and Aquatic_Parcel. Because the legal description data was spatially redundant the aquatic legal description columns were added to the Aquatic_Parcel table. While the original design of the Cadastral GDB was completed using Visio CASE, most modifications to the model for this phase were done interactively. This model proved effective for delivering the data for the Aquatic Land Ownership Arc Internet Map Service (ArcIMS) application.

A transfer process was developed to pull data from the Cadastre database and insert into the ROPA database. This was accomplished using sde2shp to create shape files and shp2sde to load the data into the ROPA system. Additional columns were updated in the Aquatic ROPA GDB from the Cadastre system using PL/SQL procedures.

After initially trying to load data into the upland Boundary, Parcel, and Legal_Description layers, it became apparent that different topology rules were needed to govern the aquatic lands. Two new feature classes were designed: Aquatic_ Boundary and Aquatic_ Parcel. A new topology was created to govern their interaction. The aquatic administrative data could be loaded into the existing Jurisdiction feature class without any problems.   The Aquatic_Parcel was a combination of the upland Legal_Description and Parcel layers with the addition of some specific aquatic attributes and the deletion of many upland attributes. At some point in the future, after significant data cleanup, the Aquatic_Boundary and Aquatic_Parcel features may be reunified with the upland Boundary, Legal_Description and Parcel layers. However, at this point the aquatic and uplands data need to mature separately.

Another issue surfaced with the simultaneous implementation of the Automated Tract Book document system and the ALO IMS viewer application. All deed documents were being transferred from ATB to Cadastre in the production environment. However, ALO IMS application users did not have the access needed to determine whether the deed was current or a historical record. The Read Only Production Access (ROPA) data transfer to Aquatic_Parcel was modified to push only the most recent deed for each parcel from production into the read environment. Land managers are now able to view only the current deed for a given aquatic parcel.

Background: Automated Tract Book Project

The ownership of state lands has been recorded in tract books since shortly after statehood in 1889. The tract books are the official register of all current and historical transactions on DNR managed lands. They serve as the primary index to the file jackets containing the actual land records, which are stored in the vault. There are approximately 60 large and very old tract books. Staff injuries were frequent as a result of handling these 40-pound books within tight quarters. Slow response time to records requests caused some transaction opportunities to be lost and was a bottleneck in certain production programs. Backup with microfilm was expensive, inadequate, and slow to recover from a disaster. A trend for increased complexity of ownership and encumbrance information and sheer volume of documents was threatening to force increased staffing. In 1996, planning started for the Automated Tract Book (ATB) project. The goals of the project were to reduce the effort to verify ownership and encumbrance status, improve the accuracy of the current tract book information, build an on-line, maintainable index to DNR's land records, and combine and analyze ownership and encumbrance information with geographic data.

After getting familiar with options for implementing a document management system, the DNR contracted IKON Office Solutions to implement the off-the-shelf document management application from OTG. The primary documents, the tract books and all ownership files, were scanned and indexed. The proprietary OTG system stores scanned images of titles, deeds, survey letters, etc. In the future, encumbrance documents such as easements, leases, and permits will also be scanned and indexed. Along with the scanned images, a desktop application is used to enter index information for document retrieval into Oracle database tables. This information was taken directly from the documents and included such items as legal descriptions, filing information, and ownership rights. This tabular attribute data was identified as being applied in the Cadastral GDB to bring in ownership information and to retrieve document images in the future, and likewise, Cadastre data could be used to help spatially index the documents by legal description, county, DNR region, etc.

Interfacing the Cadastral GDB with the ATB

One of the first steps to integrate the Automate Tract Book data with the Cadastral Geodatabase was to extend the data model by implementing three tables previously designed to be part of the Cadastral GDB: Agent, Document and Parcel_Agent_Document. Agent is a table of people or organizations having an interest in Parcels or Jurisdictions. Document is a table of the documents included as instruments of land transactions between agents and the sources where the documents are recorded. Parcel_Agent_Document is a table relating a parcel with the agents having ownership or management interests in the land and the document that legally defines these relationships.

It was clear that there would be a benefit to transferring data from the Land Records system to the Cadastre system and from Cadastre to land records. So, PL/SQL packages were created to push and pull data from one system to the other. The problem, of course, was how to associate the Land Records rows with the relational data in Cadastre. A common key had to be identified to ensure the ability to establish the correct foreign keys as the data moved from one system to the other. The solution was to install ArcReader on the desktops of the Land records staff to look up the parcel spatially and find the Parcel ID. The plan was that when a new parcel came in the Land Survey department would create the polygon spatially in the Cadastre system thereby assigning a Parcel ID to the polygon. Then as the associated documents were scanned in to the Document system by land records, they could use the ArcReader tool to look up the new Parcel ID spatially. Once the Parcel ID was known they could enter it into the document system associated with the appropriate documents and the records could be associated in the transfer system.

The Document to Cadastre and Cadastre to Document transfer systems run nightly. Because Land Records did not want any entered data to be over written, the Cadastre-to-Document system only loads records into rows that have not had certain key columns populated through the indexing application.

A particularly tricky issue to resolve and model was the relationship of parcel surface, mineral, and timber rights to the grantor (seller), grantee (owner), steward, and manager, associated with the parcel. This was data that was generally available in the land records document data, but had never been a part of the legacy POCA system. Because these agents are entered into the document management system from documents that were typed or even hand written from several sources, it is very difficult to get standard names to represent the hundreds of agents that have been involved with parcel transactions with the DNR. To solve this problem, it was decided to develop a standard list of agents from the document data. While this list was created from the Oracle table data, the determination of accepted names was an arduous manual task. Once the initial agent data was defined, the table data was modified using SQL scripts. While this was a good starting point, the task of managing the list of people and organizations will be on going.

One of the immediate findings after comparing the data between the Cadastral GDB and ATB was that there were often many historical documents transferring ownership or specific usage rights for a given parcel. However, only deeds are transferred from ATB to the Cadastral GDB. Although this has ensured that only the current deeded parcel data is transferred from ATB to the Cadastral GDB, land managers found that many documents that function as deeds such as original federal land patents get missed. Modifications were made to include these documents in the transfer. In the future, similar modifications will be made to include easement, lease, and permit documents to be related to Parcel feature subclasses without affecting the ownership parcel subclass.

After several months of operation in which owner and document data was pulled into the Cadastral Geodatabase from ATB, and legal description data was pushed out to ATB, it became apparent that there was some kind of mismatch between the two datasets. Both parcels involved in land exchanges referenced the same document id. Land managers were confused that each parcel did not have its own separate deed document. Upon bringing up the document id, there were multiple deed documents displayed, and there was no way to point to the specific deed document that was needed. The investigation of the problem found that the Title Office staff was using a single document coversheet to scan a whole transaction folder and its contents. The document coversheet is a bar-coded page that assigns the document identifier to the scanned document. The plan was to have a coversheet for each document, but staff had decided to use the coversheet for the entire file to save time. Staff would then create a separate index record identifying each GIS parcel contained within the image document set. The result was that if the whole transaction file was scanned under a single document id then all deeds would have the same document id. The land manager would have to look through all of the documents in the scanned transaction file to find a given deed.

We are still working on the solution to the document identifier problem. The plan is for the Title Office to use a separate document coversheet and assign all new documents their own identifier. An automated fix of the older records will assign a new identifier to the old documents based on the unique combination of GIS parcel identifier and the old document identifier. Then the Title Office will separate the document image pages into new documents so that the individual documents will be accessible using the new document identifier.

Spatial Views in the Enterprise Geodatabase

Spatial views are a much-neglected extension of the Enterprise Geodatabase since they are created through the SDE command line interface and modified (replaced) using SQL. They are a cross between an INFO redefine and a join, and allow calculations in addition. Field names from the layer can be named something else in the view, and the data can be operated on numerically, reformatted as a different data type, concatenated, and substringed. The spatial views are not updatable, and they are well suited for the ROPA read environment. An immediate advantage is that the layer can displayed in ArcMap based on attributes in a table related through the spatial view. Additional work is being done to speed up the spatial view access through ArcIMS. The spatial views created include Township_SV, Township_Subdiv_SV, State_SV, County_SV, DNR_Region_SV, DNR_District_SV, and DNR_Unit_SV. More views will be created in the read environment to provide a restricted set of data for public consumption.

Current Status

At this point, the aquatic and upland Cadastral Geodatabase is the agency's only transactional GDB in production. It is a relatively small system. There are just two land survey staff members committed to maintaining the aquatic and upland ownership, although two additional supervising land surveyors have extensive experience with the application, also. We continue to find problems with some of the original upland and aquatic data that was not apparent until topological validation became possible. Most of these problems have been fixed by post-processing the data retained from the conversion process.

Next Steps

Further integration of the upland and aquatic lands is necessary. Modifications of the Cadastre_GDB are being made to better track the owner, steward and manger of a system. A topology rule for overlaps and gaps in the interface between aquatic and upland lands will have to be implemented, and the interface will have to be aligned. The next phase of integrating public land ownership will be starting later this year. The DNR is responsible for mapping the lands owned by other federal, state, county, and city agencies, as well as mapping tribal reservation boundaries. Over the next few years, the DNR expects additional changes as work starts utilizing the Survey Analyst software, and external upland public ownership, lease, and easement data are added to the Cadastral GDB. The Geodatabase administration has been trying and needs to become much easier in order to implement multiple transactional datasets. We are looking forward to the improvements in GDB administration promised in ArcGIS 9.

Conclusion

As more datasets get put into the Geodatabase, it becomes easier to integrate them. The ArcMap tools have become more comprehensive. There are many timesavings, although some operations do take longer. The main result of the integration of Aquatic Land Ownership and Land Title documents has been a more integrated work environment between different work groups. Land managers have a more comprehensive view of the ownership of interest, adjacent upland or aquatic ownership, and the supporting ownership documents. The main result is that these users want more, and have indicated that the easement, lease, and permit encumbrances on the land are needed next.

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Appendix - Topologies

Upland Topology

Cluster Tolerance 0.01 US Survey Feet

Topology Rank
1 POINT
2 BOUNDARY
3 LEGAL_DESC
4 PARCEL
5 JURISDICTION
6 POCA_TILE

BOUNDARY must not have dangles.
BOUNDARY must not self-overlap.
BOUNDARY must not self-intersect.
BOUNDARY must not intersect or touch interior.
BOUNDARY endpoint must by covered by POINT.
LEGAL_DESC must not have gaps. (Mark exceptions for outside edges.)
LEGAL_DESC boundary must be covered by BOUNDARY.
LEGAL_DESC:PLS_TWP must not overlap.
LEGAL_DESC:PLS_TWP must be covered by JURISDICTION:STATE.
LEGAL_DESC:PLS_TWP must by covered by POCA_TILE.
LEGAL_DESC:PLS_TWP_SUBDIV must not overlap.
LEGAL_DESC:PLS_TWP_SUBDIV must be covered by LEGAL_DESC:PLS_TWP.
LEGAL_DESC:PLS_TWP must be covered by feature class of LEGAL_DESC:PLS_TWP_SUBDIV.
LEGAL_DESC:PLS_SECT_SUBDIV_16 must not overlap.
LEGAL_DESC:PLS_SECT_SUBDIV_16 must be covered by LEGAL_DESC:PLS_TWP_SUBDIV.
LEGAL_DESC:PLS_SECT_SUBDIV_OTHER must be covered by LEGAL_DESC:PLS_TWP_SUBDIV.

PARCEL boundary must be covered by BOUNDARY.
PARCEL must be covered by JURISDICTION:COUNTY.
PARCEL must be covered by JURISDICTION:DNR_REGION.
PARCEL:PARCEL_OWNERSHIP must not overlap.
PARCEL: PARCEL_OWNERSHIP must be covered by LEGAL_DESC:PLS_TWP_SUBDIV. (Mark exceptions.)
PARCEL: PARCEL_NON_SURFACE_OWNERSHIP must not overlap.
PARCEL: PARCEL_NON_SURFACE_OWNERSHIP must be covered by LEGAL_DESC:PLS_TWP_SUBDIV.
PARCEL: PARCEL_EASEMENT must be covered by feature class of PARCEL: PARCEL_OWNERSHIP.
PARCEL: PARCEL_RESOURCE_COMMODITY must be covered by feature class of PARCEL: PARCEL_OWNERSHIP.
PARCEL: PARCEL_LEASE must be covered by feature class of PARCEL: PARCEL_OWNERSHIP.
PARCEL: PARCEL_PERMIT must be covered by feature class of PARCEL: PARCEL_OWNERSHIP.
JURISDICTION:STATE must be covered by feature class of JURISDICTION:COUNTY.
JURISDICTION:STATE must be covered by feature class of JURISDICTION:DNR_REGION.
JURISDICTION:STATE must be covered by feature class of POCA_TILE.
JURISDICTION:COUNTY must not overlap.
JURISDICTION:COUNTY must be covered by JURISDICTION:STATE.
JURISDICTION:DNR_REGION must not overlap.
JURISDICTION:DNR_REGION must be covered by JURISDICTION:STATE.
JURISDICTION:DNR_DISTRICT must not overlap.
JURISDICTION:DNR_DISTRICT must be covered by JURISDICTION:DNR_REGION.
JURISDICTION:DNR_UNIT must not overlap.
JURISDICTION:DNR_UNIT must be covered by JURISDICTION:DNR_DISTRICT.
JURISDICTION:DNR_NAP must not overlap.
JURISDICTION:DNR_NRCA must not overlap.
JURISDICTION:DNR_HCP_UNIT must not overlap.
POCA_TILE must not overlap.
POCA_TILE must be covered by JURISDICTION:STATE.

Aquatic Topology

Cluster Tolerance 0.01 US Survey Feet

Topology Rank

1 AQUATIC_BOUNDARY
2 AQUATIC_PARCEL

AQUATIC_BOUNDARY must not have dangles.
AQUATIC_BOUNDARY must not self-overlap.
AQUATIC_BOUNDARY must not self-intersect.
AQUATIC_BOUNDARY must not intersect or touch interior.
AQUATIC_PARCEL must not overlap.
AQUATIC_PARCEL must not have gaps.
AQUATIC_PARCEL boundary must be covered by AQUATIC_BOUNDARY.

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