

# Dam monitoring and 3D survey data capture



# Introduction

The NSW Public Works (NSWPW) Survey and Spatial team boasts a distinguished history in surveying for the construction and monitoring of essential water infrastructure. This legacy is being enhanced as we embrace cutting-edge survey technologies accessible to contemporary surveyors.

Our expertise spans from traditional precise differential levelling to utilising lidar technology via drones, offering a broad spectrum of survey solutions for various projects. The foundation of our work is the strong adherence to traditional survey methods and robust quality assurance processes.

NSWPW currently offer specialised surveying services to regional councils and water asset owners throughout the state. These services include the precise monitoring of dam movements, both horizontally and vertically, and 3D data capture for projects like dam wall raising, retrofitting, rehabilitation, and remediation.

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Above: Deep Creek, Batemans Bay



Above: Malpas Dam, Green Hills

## The NSW Public Works approach

This document highlights the extensive survey capabilities of NSWPW, which can be applied to a variety of projects. At NSWPW, a capability is defined not just by the acquisition of technology but also by the combination of technology, techniques, and skilled personnel.

To ensure the optimal approach for each project, we invest time in thoroughly understanding our client's specific requirements. This process involves developing a clear project scope by identifying the capabilities that will provide the required datasets. With this clarity, we formulate a comprehensive project proposal, enabling clients to engage with confidence, knowing they will receive tailored solutions as outlined in our proposal.

NSWPW's expertise in error propagation and a methodical approach to applying emerging technology, grounded in solid survey principles, ensures that clients' accuracy requirements are met while delivering fit-for-purpose products. Our diverse range of capabilities allows for the customisation of field deployment with an optimal mix of these capabilities. Strong quality assurance and a deep understanding of error propagation enable us to accurately convey the data's precision collected using different methods.

Front page: Malpas Dam, Green Hills

# Dam monitoring lifecycle



# Precision dam monitoring

NSWPW stands out as specialists in the precise monitoring of both concrete and earthen wall dams. Currently entrusted with precision 3D monitoring survey services for 18 dams and reservoirs throughout NSW, our team showcases expertise and dedication in this critical field.

We have recently played a pivotal role in assisting three regional councils by designing and implementing precision survey monitoring infrastructure for dams. These dams were either previously unmonitored or inadequately surveyed. Furthermore, we have developed monitoring infrastructure designs for an additional five dams in the last 3 years, spanning a diverse geographic area.

To support these precision monitoring tasks, we are equipped with state-of-the-art precision instrumentation and advanced data reduction techniques. Moreover, we are both qualified and experienced in these specialised activities as these capabilities are typically beyond the resources of local councils.

Our specialised expertise in surveying enables us to:

- Review and comment on the adequacy of existing survey monitoring regimes at dams.
- Design survey monitoring networks (control pillars, instrument stations and settlement points) in consultation with dam engineers to meet the requirements of statutory dam monitoring. Factors considered at the time of design are:
  - critical components of dam structures to be monitored
  - survey observation geometry, instrument precision, of measurement principals, and network redundancy
  - construction details and potential stability of control network pillars, including means of verifying pillar stability
- construction details and surety of reported settlement point movements being truly representative of actual dam wall movements
- safety and environmental impacts of infrastructure installation, ongoing use, and maintenance.
- Procure precision engineered survey pillar and settlement point plates, and instrument mount points.
- Assist with the installation of the survey network infrastructure from construction plans and on-site location of infrastructure to advice, through to complete on-site project management in required.
- Conduct routine surveys of installed network to report on dam wall movements to a nominated precision.

# Yass Dam monitoring surveys

**Client:** Yass Valley Council

**Location:** Yass

**Services provided:** Dam monitoring survey and report preparation to the standards required by Dams Safety NSW and the Australian National Committee on Large Dams (ANCOLD) guidelines. We have carried out a total of six epoch surveys since 2007.

NSWPW have monitored the Yass Dam wall prior to, during and post, raising of the dam wall. The monitoring of the concrete dam wall demands the highest of precision, as small horizontal and vertical movements are significant in the context of concrete walls of this type. A significant challenge with dam wall raising for surveyors is to maintain continuity of movement reporting whilst survey marks on the dam wall are potentially damaged, removed and replaced.



# Bamarang Dam monitoring surveys

**Client:** Shoalhaven Council

**Location:** Nowra

**Services provided:** Dam monitoring survey and report preparation to the standards required by Dams Safety NSW and the Australian National Committee on Large Dams (ANCOLD) guidelines. We carried out a total of nine epoch surveys since 1984.

Bamarang Dam, an earthen wall structure, has been under the consistent monitoring of NSWPW for a considerable period. The primary challenges faced by NSWPW and the dam's owner at this location include adapting to changes in property ownership surrounding the dam and ensuring uninterrupted monitoring and movement reporting. This is particularly crucial during planned maintenance activities on the dam's crest, where the survey monuments are situated. Leveraging their extensive experience, NSWPW is committed to maintaining the continuity of monitoring throughout the maintenance period, ensuring consistent and reliable data collection.



# Deep Creek Dam monitoring

**Client:** Eurobodalla Shire Council

**Location:** Batemans Bay

**Services provided:** Precision monitoring survey network design, dam monitoring survey and report preparation to the standards required by Dams Safety NSW and the Australian National Committee on Large Dams (ANCOLD) guidelines.

Since its construction in 1983, the Deep Creek Dam wall had been monitored for vertical movement at discreet points. However, a recent evaluation determined that this vertical-only monitoring approach was insufficient. Consequently, NSWPW was tasked with designing a comprehensive network of monitoring monuments and a survey methodology that would allow for the effective monitoring of the dam wall in both vertical and horizontal dimensions. NSWPW assisted the council in installing these survey monuments and conducted an initial baseline survey of the new network. This baseline survey serves as a reference point for movements to be accurately measured and reported, ensuring a more comprehensive and reliable monitoring of the dam's structural integrity.



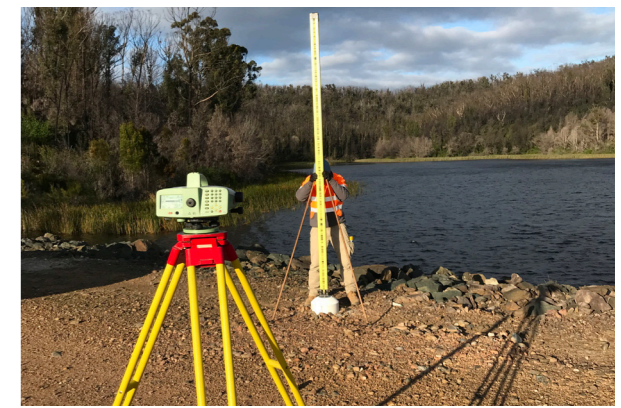
# Ben Boyd Dam

**Client:** Bega Valley Shire Council

**Location:** Boydtown

**Services provided:** Precision monitoring survey network design, project management of monument construction, dam monitoring survey and report preparation to the standards required by Dams Safety NSW and the Australian National Committee on Large Dams (ANCOLD) guidelines.

NSWPW provided Bega Valley Shire Council with a comprehensive survey monitoring solution for Ben Boyd Dam, tailored to meet the council's statutory requirements. This solution encompassed the design of a survey network with specific monuments, a detailed survey methodology, designs for the monuments themselves, and construction management services. Additionally, we conducted both baseline and subsequent surveys to accurately report the horizontal and vertical movement of the dam wall. Designing the network and methodology for Ben Boyd Dam was particularly challenging due to site-specific constraints, including neighbouring properties to the dam and limited visibility to distant landmarks like rock outcrops. To overcome these challenges, the final methodology employed by NSWPW combined precise static GNSS (Global Navigation Satellite System) with conventional survey measurement techniques, ensuring reliable and accurate monitoring of the dam.



# Dam 3D data capture surveys

NSWPW excel in capturing topographic and engineering survey data essential for various dam projects, including wall raisings, retrofitting, rehabilitation, and remediation. We adeptly combine 3D datasets from various sources and techniques, such as conventional ground surveys, bathymetric surveys, terrestrial laser scanning, drone imagery, and drone lidar. Our expertise in these areas was demonstrated in our provision of 3D survey datasets for five dams.

The data supplied is then utilised by expert dam engineers at both NSWPW and the client for several critical purposes:

- Volumetric analysis: This involves calculating the volume of materials needed for dam construction or modification. Accurate volumetric data is essential for planning and budgeting.

- Designing dam wall modifications: This includes plans for raising dam walls, demolition of obsolete structures, and infrastructure upgrades. The precise data from NSWPW informs these designs, ensuring they are both practical and compliant with safety standards.
- Review of structure and dam safety: The data enables a thorough review of the dam's structural integrity and overall safety. This is crucial for long-term maintenance and risk management, ensuring the dams continue to operate safely and effectively.

NSWPW team's capability to provide such detailed and diverse data sets underscores our role as experts in the field of surveying for critical infrastructure projects.

## Malpas Dam raising – survey and 3D mapping

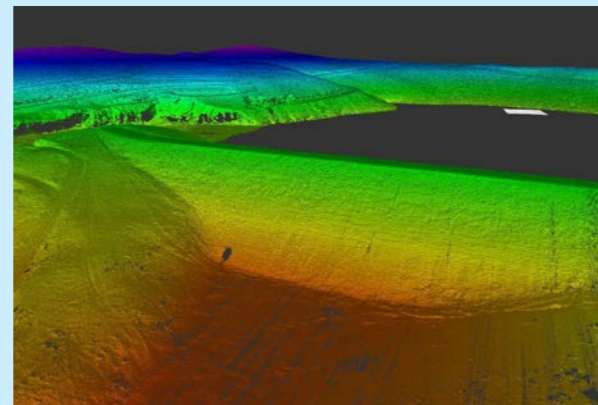
**Client:** Armidale Regional Council

**Location:** Green Hills

**Services provided:** 3D data capture over dam wall and surrounds.

The evaluation and design of Malpas Dam raising is underpinned by accurate and up to date 3D survey data. To enable the evaluation of conceptual designs and detailed design of earth works and infrastructure upgrades, 3D data was captured using drone-based lidar and high-resolution imagery, rapid handheld terrestrial laser scanning and conventional ground survey.

The data from all these sources is also merged into a seamless dataset.



## Oaky River Dam

**Client:** Armidale Regional Council

**Location:** Wollomombi

**Services provided:** 3D data capture over dam wall and surrounds.

The assessment and design of remediation efforts for Oaky River Dam relied heavily on precise and current 3D survey data. To facilitate the evaluation of conceptual designs and the detailed planning of civil works and infrastructure upgrades, a comprehensive 3D dataset was compiled.

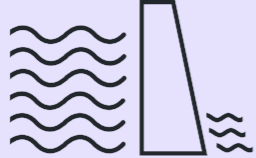


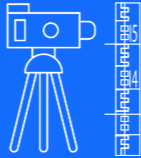




This dataset includes drone-based lidar and high-resolution imagery, terrestrial laser scanning, and conventional ground surveys. By integrating a 3D reality model derived from both drone and ground-based terrestrial laser scanning, it highlights NSWPW's ability to utilise different survey technologies to ensure the client's needs are met under all circumstances.



Above: Oaky River Dam, Wollomombi

# Survey capabilities and technologies

NSWPW Survey and Spatial team offer surveying services utilising the following technologies, techniques and capabilities that it believes are of considerable value to the inspection, assessment and monitoring of existing dams.

<p>Dam monitoring and 3D survey data capture</p> 	<p>Static GNSS</p> 
<p>RTK GNSS</p> 	<p>Differential levelling</p> 
<p>Total station data capture</p> 	<p>Terrestrial laser scanning</p> 
<p>Drone based data capture</p> 	<p>Hydrographic investigations</p> 

We use these survey acquisition techniques, technologies, and capabilities to create a single unified survey output for a structure. NSWPW possesses a robust survey foundation and embraces cutting-edge technologies to deliver precise and comprehensive accuracy assessments for every facet of a multi-technology digital twin of a structure.

These capabilities are further enhanced in the following areas:

- GIS
- data visualisation
- cadastral surveying and property matter including land acquisition.

Applications for each technology are outlined below.

Applications	
Static GNSS	<ul style="list-style-type: none"> <li>• Primary control establishment for topographic mapping.</li> <li>• Differential height determination over long distances and inaccessible terrain.</li> <li>• Precision monitoring of survey monitoring pillar movement.</li> </ul>
RTK GNSS	<ul style="list-style-type: none"> <li>• Secondary control establishment for drone operations, hydrographic investigations, and topographic surveys.</li> <li>• Topographic detail mapping and structure location.</li> </ul>
Differential levelling	<ul style="list-style-type: none"> <li>• Primary control establishment.</li> <li>• Relative heights of discrete points –i.e., water levels up and downstream for hydraulic loading calculations.</li> <li>• Precision monitoring of structures.</li> </ul>
Total stations data capture	<ul style="list-style-type: none"> <li>• Primary control establishment.</li> <li>• Topographic /detail mapping where accuracy requirements or site restrictions exceed the performance of RTK GNSS (hardstand surfaces for drainage etc, tree cover limits sky window).</li> <li>• Measurement of discrete inaccessible points.</li> <li>• Precision monitoring of structures.</li> </ul>
Terrestrial Laser Scanning (TLS)	<ul style="list-style-type: none"> <li>• Rapid 3D capture of complicated engineered structures.</li> <li>• As-built surveys of complex structures, particularly those that would not be adequately described by a small number of discrete points or where there are few recognisable discrete features e.g., the face of a concrete dam wall.</li> <li>• Measurement of inaccessible structures.</li> <li>• 3D digital twins and CAD renderings of structures.</li> <li>• Precision monitoring of the deformation of surfaces rather than discrete points.</li> </ul>
Drone based data capture	<p><u>Photogrammetry</u></p> <ul style="list-style-type: none"> <li>• Rapid 3D capture and detail mapping of hard stand areas.</li> <li>• Orthophotos for CAD and GIS background imagery.</li> </ul> <p><u>Lidar</u></p> <ul style="list-style-type: none"> <li>• Rapid capture Digital Elevation data in vegetated areas (trees).</li> </ul>
Hydrographic investigations	<ul style="list-style-type: none"> <li>• Volume determination, and areas of inundation.</li> </ul>



Sooley Dam, Kingsdale

# Why choose NSW Public Works?



**Accredited for planning and delivery of capital works**

NSWPW is accredited under the NSW Government Agency Accreditation Scheme for Construction to manage the planning and delivery phases of construction and capital works procurement. NSW State and Local Government entities can directly engage the services of NSWPW under the provision of NSW Government Procurement Board Direction PBD 2020-04 and Section 55 of the Local Government Act 1993, providing efficiencies and cost savings.



**Strong focus on quality, environmental and safety management**

NSWPW operates under triple certification for quality, occupational health and safety (WHS) and environmental (QSE) management systems. These systems and processes provide the foundation for delivering quality projects and a continuous improvement culture, that embraces QSE leadership at all levels and integrates QSE into all activities. NSWPW' Project Management Framework is the backbone of our quality system and is used to manage our projects and ensure we deliver to agreed requirements.



**State-wide resources**

Regional clients benefit from our state-wide network of offices enabling them to source expert project management personnel familiar with the conditions and construction industry issues in their area. This proximity reduces servicing costs, facilitates improved stakeholder communications and enables us to respond quickly to your needs, providing a single point of contact for all services.



**Government relationships and knowledge**

Successful delivery of complex infrastructure projects relies on effective interaction with stakeholders and regulatory government agencies. NSWPW' unique position within NSW Government enables us to bridge the gap between our clients and Government stakeholders to ensure necessary consultations and approvals are undertaken efficiently and effectively.



**Managed risks**

We place considerable emphasis on advising clients of their risks on projects, including the options and costs to manage these risks. Wherever possible, risks are identified early and inform our planning and procurement strategy development processes. Risks are continuously monitored and updated as projects progress and discussed and managed with clients and contractors.

# Working across NSW

## HUNTER NEW ENGLAND REGION

**Newcastle**  
117 Bull Street  
Newcastle West NSW 2302

**Tamworth**  
155-157 Marius Street  
Tamworth NSW 2340

**Inverell**  
240 Byron St  
Inverell NSW 2360

**Armidale**  
85 Faulkner St  
Armidale NSW 2350

## NORTH COAST REGION

**Lismore**  
120 Dally Street  
Lismore NSW 2480

**Coffs Harbour**  
359 Harbour Drive  
Coffs Harbour NSW 2450

**Port Macquarie**  
Level 2, 41-47 Horton Street  
Port Macquarie NSW 2444

## SYDNEY METRO

**Parramatta**  
4 Parramatta Square  
12 Darcy Street  
Parramatta NSW 2150

**The Rocks**  
66 Harington Street  
Sydney NSW 2000

## SOUTH COAST REGION

**Wollongong**  
Level 3, Block E  
84 Crown Street  
Wollongong NSW 2500

**Goulburn**  
Suite 5, 167 Auburn Street  
Goulburn NSW 2580

**Moruya**  
66 Campbell Street  
Moruya NSW 2537

**Queanbeyan**  
Ground Floor East  
11 Farrer Place  
Queanbeyan 2620

## RIVERINA/WESTERN REGION

**Bathurst**  
Level 1, 346 Panorama Avenue  
Bathurst NSW 2795

**Dubbo**  
34 White Street  
Dubbo NSW 2830

**Broken Hill**  
Level 1, 32 Sulphide Street  
Broken Hill NSW 2880

**Griffith**  
104 - 110 Banna Avenue  
Griffith NSW 2680

**Wagga Wagga**  
2-6 Coleman Street  
Wagga Wagga NSW 2650

**Dareton**  
1998 Silver City Highway  
Dareton NSW 2717





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