VISUAL ASSESSMENT OF UTILITY ASSETS

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VISUAL ASSESSMENT MANUAL FOR UTILITY ASSETS

Developed on behalf of the NZWWA Water Services Managers' Group

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Feedback and suggestions

The images used as examples came from a number of sources including public domain sources. Other images were taken specifically for this project.

Images of pipe bridges were sourced from Rodney District Council.

If we have inadvertently overlooked acknowledging an image, please contact the NZWWA so that a suitable acknowledgement can be included.

A work of this type can never hope to include top quality images of every major type of defect in its first version.

If you have better images than images used here, please contact the NZWWA. The NZWWA would also like to hear from you if you have good quality images of structures or materials in intermediate condition or if you have images that show features not presently included in this manual.

Amendments

Amendments			
Number	Date of issue	Description	Entered by, and date

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ABOUT THE MANUAL

Purpose

This manual has been prepared to help people conduct mainly visual assessments of smaller civil plant such as buildings, tanks and pumping stations plus routine visual assessment of the associated mechanical and electrical equipment (pumps, control boards, telemetry and alarms). While it may be useful for people inspecting larger plants and assets servicing more than 10,000 people, it is mainly aimed at small to medium plants and assets servicing between 101 and 10,000 people.

The manual is also intended to be useful for people managing condition assessments or using the outputs to see how the assets change in service and to establish threshold conditions that show when some form of intervention – repair, maintenance or replacement - is required.

The need for condition grading

Infrastructure condition information underpins a wide range of asset management activities ranging from asset valuations through to managing renewals planning and setting investment programmes.

Current legislation (for example the Local Government Act 2002), requires local authorities to manage their assets in the interests of their communities. Compliance with legislation and business requirements is monitored and enforced through auditing. It is also good business practice to have a robust asset management programme in place even where not mandatory.

This manual is intended to help operational and engineering personnel apply rational, consistent and justifiable condition ratings to a wide range of assets. It is expected that this will in turn help Local Authorities and Utility Operators to meet their asset management obligations and to provide the robust information that is increasingly expected by regulatory and auditing bodies.

The case for visual assessment

Visual assessment is a simple and effective way to collect information on the condition of readily accessible assets. Visual records allow operators and contractors to compare the present state with an earlier photograph – for example during a routine maintenance check. Visual assessment reports can also be used as a robust and traceable source of information for more advanced asset management purposes.

While some assessment requires specialist personnel or equipment, the visual assessments described here provide valuable supporting information and can be used to identify when more specialist intervention may be needed.

Scope

This manual has been developed to meet a number of objectives:

- provide an entry-level guide to determining the condition grade of utility assets that are accessible in the course of routine operations and maintenance activities using predominantly visual assessment;
- provide example condition reports that can be used to guide future assessments;
- provide guidance on threshold conditions at which more specialised intervention is required;
- address a target audience of plant operators and contractors, while being useful for people who manage these kind of assessment programmes or who manage individual plants;
- primarily cover small to medium plants servicing populations in the range of 101 to 5,000 people and also be applicable to medium sized facilities serving up to 10,000 people; and
- provide a convenient reference for people involved in related asset management work.

(**Note:** For convenience, we have related the scope of this work to the drinking water supply categories in the Health (Drinking Water) Amendment Act. Thus the size range of small to medium covers populations supplied of between 101 and 10,000 people.)

Exclusions

The manual is not intended to cover the following types of assessments:

- formal mandatory inspections and assessments such as those required by legislation for Health and Safety purposes (for example inspection of dams, pressure vessels);
- larger assets servicing communities in excess of 10,000 population;
- assets that are normally inaccessible in the course of routine operations – for example buried pipelines, plant inside vessels that are normally closed or that otherwise require special access provisions; and
- assessment requiring specialist skills or specialist equipment.

In all of these excluded cases, however, it is anticipated that the manual will still provide useful guidance on how to assess these assets where this does not conflict with the statutory inspections.

The use of this manual

While larger assets and more critical assets are addressed through formal periodic assessments, there are many smaller assets that in aggregate make up a significant part of the water infrastructure. Often these smaller plants are assessed in passing by operators or contractors since specialist assessments are difficult to justify. In the absence of guidance, these non-specialists are often left to their own devices to determine the condition grade and style of reporting. Even where individuals have sufficient experience to make a useful judgement of condition, the absence of supporting guidance leads to substantial variability.

The manual provides guidance on how to go about an assessment, what to look for, how to report it and when to call on more specialist services.

Where possible, we have built on existing expertise and knowledge. For example, the categories of structures are based largely on the classes in the NZWWA "New Zealand Infrastructure Asset Grading Guidelines – Water Assets" from 1999, and a grading system of 1 "Good" to 5 "Failing" has been retained, although the grades have been adjusted to better assist asset managers relate the findings of asset assessments to their programmes of works.

We have also taken account of other relevant industry publications so as to benefit from existing expertise while minimising potential conflicts in approach.

The structure of the manual

The manual is divided into the following sections:

Glossary This section defines key words relevant to asset management and visual assessment of utility assets.
Section 1 – General information This section provides an overview of the tasks that can be completed using mainly visual assessment of condition
Section 2 – Guidelines for Inspection This section provides an overview of how to conduct a mainly visual assessment of condition
Section 3 –Condition Grade examples This section provides examples of condition grades
Appendices These sections provide supporting information

GLOSSARY

ABOVE GROUND ASSETS
Pipework or assets that are visually accessible without excavation. It can include assets that are visible within pits or are visible by opening an accessible cover or hatch or by using normal access ways in the plant. However, the fact that an asset is visible does not necessarily mean that it is safe to approach it and normal plant Health and Safety practices should still be followed.

ASSET
A physical component that has value, enables service to be provided and has an economic life greater than 12 months. For example a storage reservoir or a pump set.

ASSET MANAGEMENT
The combination of management, financial, engineering and other practices applied to physical assets with the objective of providing the required level of service in the most cost-effective manner.

ASSET MANAGEMENT SYSTEM
A system, usually in the form of computer software, that contains an inventory of assets and links to asset history, condition and financial information. The software can generate reports about assets, including information about condition.

ASSET MANAGER
The person responsible for managing assets.

ASSET NUMBER
A unique number allocated to an asset or component. It may be different from other identifiers used. For example, pump numbers or pipework identifiers which identify items in a pumping station will not be the same as the asset number.

ASSET REGISTER
A record of asset information including inventory, history, condition, construction, technical and financial information.

ATTRIBUTES
Physical properties of an asset. For example, the capacity of a tank or vessel.

CONDITION
The present state of a physical asset, usually referring to the structural integrity. It can also relate to the appearance.

CONDITION ASSESSMENT
The systematic determination of the present state of a physical asset.

CONDITION GRADES
A numerical or descriptive value that provides an indication of the state of a physical asset. Water Industry assets are usually graded 1 “Excellent“ through to 5 “Failed“ but other systems, with more or fewer grades or alternative descriptions are possible.

CONDITION DATA
The separate components of condition records. Data may include position information or condition grades.

CONDITION RECORDS
The recorded information that identifies an asset defect or feature. The information may include such items as the position of an asset or components.

CONTRACTOR
The company or person appointed to carry out the physical work by the Principal.

DESTRUCTIVE TESTING
Testing that causes some form of damage to an asset. Examples include cutting out a section of pipe for inspection or taking a core sample from a concrete structure.

ENGINEER
The Engineer to a contract as defined in the contract.

GEOGRAPHIC INFORMATION SYSTEM (GIS)
Software which provides a means of spatially viewing, searching, manipulating and analysing an electronic database.

GLOBAL POSITIONING SYSTEM (GPS)
A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

INFRASTRUCTURE ASSETS
Stationary systems forming a network and servicing whole communities where the system as a whole is intended to be maintained indefinitely at a particular level of service by the continuing maintenance and replacement of its components.

INSPECTION DATA
The separate components of inspection records. Data may include position information, date or time, the lead inspector or condition grades.

INSPECTION RECORDS
The recorded information that describes the results of an inspection of an asset. The information may include such items as the position of an asset, reference to previous inspections, the reasons for the inspection and the actual results of the inspection.

INSPECTOR
The person inspecting the asset(s). An Inspector may have relevant training and experience but this is not a requirement.

LARGE
An asset or plant servicing a population in excess of 10,000.

LEVEL OF SERVICE
The defined service quality for a particular activity or service area against which service performance may be measured. Service levels relate to quality, quantity, reliability, responsiveness, environmental acceptability and cost.

MEDIUM
An asset or plant servicing a population of between 5,001 and 10,000.

MINOR
An asset or plant servicing population of between 201 and 1,000.

NON-DESTRUCTIVE TESTING
Testing that causes no significant damage to an asset. Examples include measuring the wall thickness using ultrasound, or conducting a camera inspection. Even where damage caused during testing can be fully repaired (eg after coring of concrete) the test is usually regarded as destructive.

Tests that only cause a small amount of damage are sometimes considered to be non-destructive.

REPORTING BY EXCEPTION
A form of reporting that highlights things that are different. This type of report normally includes a brief comment on the bulk of a plant, and more detail on the problem areas.

SMALL
An asset or plant servicing a population of between 1,001 and 5,000.

SPECIALIST ASSESSMENT

Assessment by contractors with qualifications or experience relating to asset inspection and assessment. This includes assessment using measurement, testing or imaging equipment to obtain additional information above that obtained during a visual assessment where the operators are suitably trained, experienced and qualified to ensure safe, successful and effective use of the equipment.

VISUAL ASSESSMENT

Visual Assessment is the direct evaluation of those properties of a physical asset that are visible by the naked eye (with or without portable magnifying aids) and can be evaluated directly in the field.

Visual assessments can be complemented by using the other senses – sound, smell, touch (taste is not appropriate for obvious reasons).

1 GENERAL INFORMATION

1.1 The role of visual asset condition assessment

1.1.1 What does visual assessment mean?

Visual assessment involves determining the present state of an asset by observing visible features, with or without optical aids such as binoculars, magnifying lenses or cameras. This manual covers predominantly visual assessment, but includes other simple assessments that do not require specialist equipment.

The assessment methods considered are:

- Visual (with or without magnification through camera zoom or binoculars)
- Supporting checks
  - switching components on or off, checking that fittings are secure, doors open and shut, locks work, and measurement of dimensions, clearances.
  - other senses – is a machine vibrating unusually or is it noisy, are there smells that indicate a leak or overheating, is a component unusually hot.

1.1.2 Why are visual assessments conducted?

Visual assessments are undertaken to provide a rapid and cost-effective check on the condition of an asset. This can be done as part of an ongoing programme of inspections or as a one-off standalone exercise.

Data obtained by visual assessment can be used to:

- determine the condition of assets;
- identify visible faults, especially those that need urgent action;
- identify the need for a specialist assessment;
- provide an overall inventory of the asset and an overview of system problems;
- assist in regular maintenance planning;
- record current asset status for valuations;
- provide a record of asset status for condition tracking; and
- assist in risk analysis and hazard identification – for example trees overgrowing telemetry antennae, or animals in a supposedly secure area.

Visual assessments can also be used to confirm inventory information such as the size or configuration of plant, or to create and validate as-built drawings and process and instrumentation diagrams (PIDs). For example:

- interconnections – which vessels are connected to which;
- the size of a vessel;
- the construction of a vessel (what it is made of or how the components are connected);
- the make or model of pumps; and
- the configuration of pipework and telemetry systems.

1.1.3 What information can be determined by visual assessment?

A visual assessment provides information that can be used for asset management, asset maintenance or asset rehabilitation purposes. Visual assessment provides information that is directly related to the condition of the asset along with information on what and where the asset is.

1.1.4 What cannot be determined by visual assessment?

Visual assessment cannot:

- provide information about the inside of an enclosed structure. While the sound or feel of an asset may reveal some relevant information, visual assessment cannot confirm wall thickness, the condition of the bulk fabric of a structure or the presence or state of internal defects or the state of the inside surface.

Visual assessment is also limited in its ability to:

- distinguish between surface features and features that affect the bulk of the structure;
- identify the underlying causes of a problem; and
- confirm the internal configuration of plant.

More specialist assessment may be required to address these factors.

1.1.5 What assets are covered?

The following assets from the tables in the NZWWA Infrastructure Asset Grading Guidelines are included because visual inspection can provide at least some information relating to condition:

- the surface parts of manholes and other inspection ports and points;
- buildings (eg pump station housings, storage sheds);
- reservoirs and treatment plant structures - tanks, inlets (described as civil structures);
- mechanical and electrical equipment;
- above-ground pipework and valves (including pipe bridges); and
- general site issues relating to access, security and appearance.

Summary of the tables from the NZWWA Infrastructure Asset Grading Guidelines covered in this Manual.

NZWWA Table	**Description**	**Comments** are comments in the tables of the NZWWA Infrastructure Asset Grading Guidelines **Notes** are additional to the original comments
C4	Wastewater and Stormwater – Manholes	**Note**: Also covers Table C14 Stormwater manholes
C5	Surface operational assets – Civil structures	**Note**: Also covers Table C15 Stormwater Detention Tanks and Table C16 Stormwater Inlets and Outlets
C6	Surface operational assets – electrical and mechanical plant	**Comment:** Pumps, motors, generators, transformers, switchgear, cabling, telemetry, automatic controls, process plant, reticulating sand filters **Note**: Also covers Table C9 Electrical and mechanical equipment and C18 Stormwater Pump station – Electrical and mechanical components and parts of Table C17 Stormwater Pump Station**.** **Note:** Only limited information can be obtained by visual assessment.
C7	Buildings	**Comment:** Structures to provide secure weather proof housing for equipment or personnel. Also access, site security and safety. **Note**: also covers part of Table C17, Stormwater Pump Station
C8	Civil Structures	**Comment:** Structural works – dams, reservoirs and tanks. Also tunnels and pipe bridges.
C10	Pipework and valves	**Comment:** Above ground pipework associated with pumping stations valves and meters. Also gates, penstocks, lifting gear.

1.1.6 What is the role of visual assessment in asset management?

The purpose of asset management is to provide an agreed level of service in a cost-effective manner through the creation, operation, maintenance, renewal and disposal of assets to provide for the needs of future and existing customers.

Visual assessment can help management and stakeholder organisations understand the existing condition of their visible assets. This understanding will help the asset manager make decisions such as which assets are:

- showing evidence of impending failure or significant loss of performance;
- in need of maintenance works such as cleaning, unblocking or repainting; and
- in need of specialist assessment

This assists the asset manager in both prioritising works and preparing a programme for any required works.

1.1.7 An outline of the visual assessment process

The key stages of a visual assessment include:

- agreeing the purpose of the assessment;
- deciding which assets are to be inspected;
- establishing a benchmark or reference standard for the inspection;
- preparing for and conducting the assessment
- checking the information obtained is accurate and sufficient;
- processing and storing the data;
- interpreting the findings; and
- generating the required outputs.

1.1.8 Key points of a visual assessment

In order to be useful a visual assessment should:

- be recorded clearly and accurately so different inspectors can understand each other's assessments;
- be consistent so that different inspectors identify the same features in the same way;
- identify the most significant faults, even if this means passing over some minor ones;
- be conducted without hindering the operation of the plant or asset being inspected; and
- not expose the inspector to any unnecessary hazards.

1.2 The assessment

This Section outlines the key stages in preparing for, conducting and reporting on an assessment in order to provide consistently useful information.

1.2.1 Preparation for inspection

Surface deposits and corrosion products can hide the true state of assets and hinder visual assessments but the same deposits and corrosion products can say a lot about the state of the asset.

The inspection brief will say whether cleaning is required and what standard of cleanliness is required. Where cleaning is recommended before inspection, it is important to record the state of the asset before cleaning.

1.2.2 Planning the assessment

Some assets are more easily treated as smaller sub-assets so that different types of components or stages in the process are each handled separately. Examples include:

- for a pumping station, considering the access, containment building, the pump set and the control panel as distinct components;
- for a treatment plant, assets from the different parts of the treatment process – settlement tanks, filter units, disinfection – could each be treated separately;
- for a pump set, the pump, the motor, the controller and associated valves and pipework could all be considered individually; and
- for buildings, considering the walls, roof, doors and windows separately.

The level of detailed asset breakdown required for an assessment varies according to the asset, and also with the intended use of the data. It is usually adjusted by individual utility owners through a gradual process - for example as exceptions to a general classification are noted, or as specific information requirements are identified.

For larger plants, it can also be useful to plan assessments by the type of component, rather than trying to assess the entire plant all at once, for example by using an inspection to consider all the:

- mechanical components;
- electrical components;
- civil components; and
- telemetry components.

Conducting assessments in pairs or small teams can also be helpful as each person can be made responsible for assessing one type of component while pointing out features of interest to the other assessors. For example, while looking at basic site security a jamming door may turn out to be caused by a leak that would otherwise have gone unnoticed.

Working in small teams of two or more people also reduces the Health and Safety risks during an inspection. Where this is not practical (for example if conducting an inspection as part of another job that involves working alone) it may be necessary to limit the scope of the inspection so as to minimise any risk.

1.2.3 Recording assessments

Assessments should be recorded so that someone else can return to the site and understand what was assessed, when it was assessed and what state the assets were in. Written descriptions alone are rarely sufficient and the preferred approach is to include images of the assets. These should show the present condition of the key components, and of any exceptions that are in substantially better or worse condition.

It is also useful to include a general photograph or plan of the site and mark on it which assets were inspected. This also makes a useful check list so that it is less likely that anything is overlooked.

After the first inspection, it can be useful to take repeat photographs from the same viewpoint or of the same defect on each visit. This provides a record of how the asset has changed since the previous inspection. Over a few years, this kind of record becomes increasingly valuable to the asset owner.

1.2.4 Quality Assurance

Quality Assurance is used to demonstrate that the key critical points of your business have been considered and that relevant procedures have been followed.

For the purpose of visual condition assessment the key information is:

- what was inspected and where it is;
- when it was inspected;
- who conducted the assessment;
- what process or techniques were used; and
- what conditions could have affected the assessment (eg rain will often obscure leaks, part of the site may have been inaccessible during the inspection or bad light prevented a proper inspection).

What checks should the Principal make?

- Competency – that the inspector has the experience and capability to carry out the work.
- Accuracy - existing asset records can be checked against assessments to see if they match up.
- Consistency - previous assessments should be compared to see if present and past records match up.

Maintaining consistency from one inspection to another is particularly important and visual assessments backed with photographs usually provide a more consistent record than written descriptions.

Auditing and Review Procedures

Auditing and review are used as part of the Quality Assurance process. The main function of auditing and review of visual assessments is to promote consistency between different inspectors and between different inspections.

Reports based around photographs showing asset condition provide a more robust record than reports based on written descriptions since images are more objective. For example, a reviewer can check that the images in the report against the example images in this manual. It is also possible to check records made over a few years to see if recorded features have changed as expected.

A reviewer or inspector can also take the report to the site, look for the reported features of interest and compare these with the state of the asset at the time of the visit.

1.3 Health and safety

Most plant and assets are potentially hazardous and appropriate precautions are needed during an inspection. At a minimum, local plant safety procedures should be followed and the usual protective equipment and precautions required during normal plant operation should be used.

Conducting the inspection may in itself create some additional hazards. Appropriate precautions will be required to address these. Some examples of where hazards could arise during an inspection are noted below.

1.3.1 Confined spaces

Many plants and sites include areas that are considered as confined spaces. For example the inside of a manhole or a tunnel and many other structures can be considered a confined space. Working in confined spaces is a specialist job that requires properly trained personnel and working procedures. Inspection of confined spaces is therefore not considered in this manual as it is considered a specialist activity.

Confined spaces can include places that are not enclosed and appropriate safety procedures may be required for a visual assessment from the outside even when the inspector does not enter the space itself.

Confined spaces should be identified in the local plant safety procedures, but it is important to be completely sure whether an area is a confined space or not before entering it.

1.3.2 Access

In most cases, access to out-of-the-way components will be gained by using existing access ways. The plant Operations and Maintenance manual should describe how to safely access the various parts of the plant. Specialist assessment using scaffolding, cherry pickers, abseiling or other techniques to get to otherwise inaccessible parts of a site are not covered in this manual.

More remote or inaccessible plant can often be viewed with binoculars or by using a camera with a good optical zoom. This is discussed further in Section 1.4.1.

When using binoculars or other optical equipment looking into the sun, even accidentally, can cause permanent eye damage. This is most likely to happen when looking upwards at elevated structures and can be avoided by thinking about which angle to view the structure from.

1.3.3 Electrical safety

In some cases, taking standard electrical or battery powered equipment into a site is not permitted because it could be a spark or explosion hazard. This can include cell phones, cameras and torches. If electrical equipment is not permitted, condition information will have to be recorded by hand or possibly recorded afterwards, unless it is possible to get a good view of the plant from outside the restricted area using high magnification equipment.

The local plant safety procedures should define any special requirements.

1.3.4 Hazardous materials

Apart from the more obvious hazards from chlorine or other chemicals, some plants include components containing asbestos or lead. Pipework and roofs made of asbestos cement are quite common, and older components might have lead paint. These are not likely to present a major hazard during a visual assessment unless disturbed, but it can be difficult to identify them visually.

Hazardous materials should be recorded in the local plant Operations and Maintenance manual.

1.3.5 General issues

Moving parts and electrical hazards are just as dangerous during an assessment as in normal operation, so normal plant safety procedures should be followed.

Although it can be useful to operate switches, handles and controls as part of an inspection, just because you are doing an inspection does not mean it is safe to do this. The plant Operations and Maintenance manual and warning signs in the plant will give some guidance, but the best advice is to treat all equipment as live and only touch things you know for sure are safe to touch.

Wearing gloves is a good idea as the component could be hot or cold, may have sharp edges or possibly have surface contamination .

A person conducting a visual inspection may be at greater risk of tripping or falling than during normal asset operations because their attention is elsewhere. The simplest way to avoid this is to stay still while looking, move along, then stop again and continue the inspection.

Before entering a site or starting an inspection, check that the site is as you expected. Many sites are in constant use and other activities could be going on or could start during an assessment.

1.4 The tools

This section provides an overview of aids to visual assessment and examples of some of the more detailed assessment techniques that could be brought in to support a visual assessment. In any visual assessment, the single most important tool is an observant person.

1.4.1 What tools and equipment should be used?

The main assessment methods will be:

- visual (with or without magnification through camera zoom or binoculars);
- simple hand tests – switches turn components on or off, valves rotate, fittings are secure, doors open and shut, locks work, measurement of dimensions, clearances; and
- site records – plant records can be used to check when plant was last serviced, maintained or repaired. r (in-depth analysis of site records is not covered in this manual.)

The main tools will help inspect the asset and record its condition.

Visual aids

Binoculars or a camera with an optical zoom are good for inspecting inaccessible parts of the plant – high parts of a water tower, or even the far side of a channel or pond.

This is particularly useful for areas with difficult access that would otherwise need specialist access equipment such as scaffolding or that present safety hazards. A magnification of up to around x8 usually provides a reasonably stable image in handheld equipment. A small tripod will help at higher magnification and some more advanced cameras have a stabilisation system that can produce a steady image even at very high magnifications above x10 or x12.

While binoculars are still useful, cameras are needed to provide a record of condition. A camera will usually be a better choice than binoculars if it has a suitable optical magnification.

A light source such as a torch or inspection lamp is useful. The amount of light needed depends on many factors including the inspector, the weather, the location, and on the information required. Too much light can create overexposed images or bleach out contrast when trying to see details. Be aware that some areas may need electrically safe equipment.

Many built-in camera lights and flash usually have a shorter range than the zoom, so some highly enlarged images may appear dark. An inspection lamp or separate light source may be useful.

A mirror on the end of a pole can help show otherwise inaccessible spaces.

Measurement and marking aids

It is useful to know where an interesting feature was, or to know how big a defect is. Spray paint, crayon or marker pens can be used to mark positions of interest or to label components before they are photographed.

A tape measure can be used to measure the size of a defect and to record its position. Including a ruler in a photograph provides an idea of the size of the item but otherwise everyday items like a coin or a pen can give an indication of scale.

> **Note** that 50 and 20 cent coins are best avoided as the older large coins and newer smaller coins have the same design and can not be distinguished in a photograph.

Supporting checks

Simple supporting tests using the other sense - smell, sound, touch - can be used to complement a visual inspection.

- Sound – This is particularly useful for mechanical and electrical parts. Does the machine sound like it is running properly, do moving parts creak and squeal or operate smoothly, do alarms sound when tested? A simple sounding survey for concrete is conducted by tapping with a hammer to listen for a hollow sound which could indicate a delamination problem.

- Smell – A smell of hot or burning materials may warn of overheating and other smells that may indicate a change from the usual treatment process – eg spillage or leakage.

- Touch – Where it is safe to touch components, they can be checked to see if they are running roughly or smoothly, are the bolts done up correctly or if the attached plant vibrating excessively or does it feel unusually hot or cold. Touching a bolt head can check if it is secure or for a coating can tell if is firmly attached and if the coated material is sound.

  A feeler gauge may be useful when checking for loose components or crack sizes and a small metal or plastic probe can be useful for checking softening or bonding between two components. However, it is important not to make any damage worse.

- Experience – Not exactly a sense, but a useful aid to inspection. If something doesn't seem quite right, it may be worth taking a second look or at least noting that it seemed wrong.

Specialist assessment techniques that require specialist equipment or specialist skills are summarised in Section 1.4.3.

1.4.2 Recording assessments

Inspection records should preferably rely mainly on photographs with supporting written notes. An example report is shown in Appendix B, but other layouts can be used. Video footage, sketches, and sound recordings made during the inspection can also be useful, but excessive amounts of video footage can take too long to view and draw attention away from important features.

If electrical equipment is not permitted on sites or on parts of sites due to spark hazards, a rough sketch or marked up drawing may be needed. Otherwise it may only be possible to conduct an inspection during a plant or process shut-down.

Reporting and information storage requirements will usually be covered in the inspection brief or contract. If no instructions are given, it is important to make sure that old reports and records are kept and are not over-written, since the original condition and how it changes can provide valuable information.

1.4.3 Specialist assessment

Visual assessments may only provide part of the information. Other techniques can be used to get more or better information. Often the visual assessment will be used to work out whether a more specialist assessment would be useful.

> **NOTE:** All of the techniques described below are only for use as part of a specialist assessment. Although the equipment described can look easy to use, it is very easy to get unusable or misleading information if not used correctly, and some can cause damage to the plant.

Infrared photography or infrared video imaging

Infrared imaging systems respond to heat rather than light. Infrared images can reveal information about some sub-surface features or about electrical faults that cause local heating.

Like optical imaging, infrared imaging is quick and is completely non-destructive. However, infrared imaging equipment is usually more expensive and less robust than optical imaging equipment and requires more skill in interpretation so is only available as a specialist activity.

Physical testing

Concrete and reinforced concrete

Various techniques can be used to assess the cause and extent of concrete and reinforcement deterioration. These include measurement of the depth of concrete cover, sampling of concrete to determine levels of contamination, removal of cores for strength assessment and assessment of reinforcement corrosion by excavation and electrical testing.

These all require specialist equipment. When samples are recovered or concrete is broken open to check the state of reinforcement, it is particularly important to avoid causing structural damage and to repair the opening correctly.

Coated structures

For coated structures, the most important things are how complete the coating is and whether it has bonded properly or not. Coating thickness gauges, pull-off testing machines and spark testers (which detect small pinholes known as holidays) are all used. Pull-off machines create a small amount of local damage that needs to be repaired correctly.

Wood

For wooden structures common tests include: pressing to check for softening, checking for softening using a sharpened spike, boring to determine the location and depth of decay, and coring to provide samples for identifying the type of wood.

Even the simplest of these tests should be used with care as they have the potential to weaken the structure of the remaining wood.

Metals

For metals, metallographic tests, corrosion investigations and non-destructive testing (ultrasound or electromagnetic testing) can be used. These all require specialist input both to ensure that the information obtained is useful and to avoid damaging the components.

Plastics

A wide range of tests can be used on plastics, but most requires a sample to be taken away fro testing. Common tests include infrared tests, X-ray or electron microscopic testing or optical microscopy. These tests can be used to identify which materials have been used and to detect evidence of damage or deterioration. As with metals, the tests have to be planned and conducted by specialists.

Supporting assessments

Information on water or wastewater quality, investigations of treatment processes and other reviews such as failure investigations, energy usage audits, maintenance and testing records etc can all provide useful supporting information.

Other useful specialist assessments include structural analysis, and using computer models to predict the effect of failures on customers or on the receiving environment.

2 GUIDELINES FOR INSPECTION

Most visual assessments will be used to provide information for use in asset management.

2.1 Condition assessment

The condition of an asset affects its ability to provide a useful service. An asset that is damaged or in poor condition will often fail to perform and will usually be expensive to operate and maintain.

By conducting regular asset condition assessment, asset managers can update and refine their asset management programmes so that they can better programme their replacement and upgrading works.

Condition assessment is an integral part of asset management. The timing of inspections is influenced by the requirement to provide information for use in annual plans, valuations, asset management plans (AMPs) and Long Term Community Consultation Plans (LTCCPs) as well as by the recommendations from earlier assessments. The results are used for valuations, grading, maintenance and renewals planning and to check the underlying ability to deliver required levels of service. The results of condition assessments can also be used to guide selection of materials for new works that will, in time, be the subject of valuations and management plans.

2.2 Visual assessment

Because it is relatively cheap, quick and is non-destructive, visual assessments are a valuable tool for assessing or monitoring asset condition provided the information is recorded in a consistent and accessible manner. Even when it only provides limited information on condition it can be useful for building up a record of condition change over time to help identify critical changes in future. Identifying this intervention condition can be as useful as identifying the onset of actual failure.

Despite being limited to surface-detectable changes, visual assessment has a number of advantages:

- it is quick;
- it is non-destructive;
- it requires little specialist equipment;
- it can cover a large survey area;
- it can be applied to a wide variety of assets and materials; and
- photographic records show the history and development of previous assessments.

Depending on the client requirements, visual assessment may be used to:

- confirm plant layout;
- check compliance with codes of practice;
- assign a grading;
- identify where further assessment is appropriate; or
- assign a grading AND identify where further assessment is appropriate.

Visual assessments can be used to help with:

- condition surveys;
- maintenance planning;
- quality checks of repairs or remedial works;
- valuations for insurance or obligations under the Local Government Act; and
- security checks and audits.

In most cases, a visual assessment conducted for one of these purpose will also be useful for a number of the other purposes.

2.3 Developing a visual assessment programme

Usually the visual assessment programme will be developed by the asset manager to tie in with company or council reporting requirements.

Factors that are taken into account include:

- What can be determined by the assessment?
- How often to do it?
- Who should do it?
- What can be done with the information?
- What effect the inspection has on the plant?

2.3.1 Objectives of Visual Assessments

Visual assessment can give an overall impression of condition of an asset or set of assets, but it does not address all aspects of condition and a one-off assessment may not be any help in determining whether a defect is new or has been there since construction.

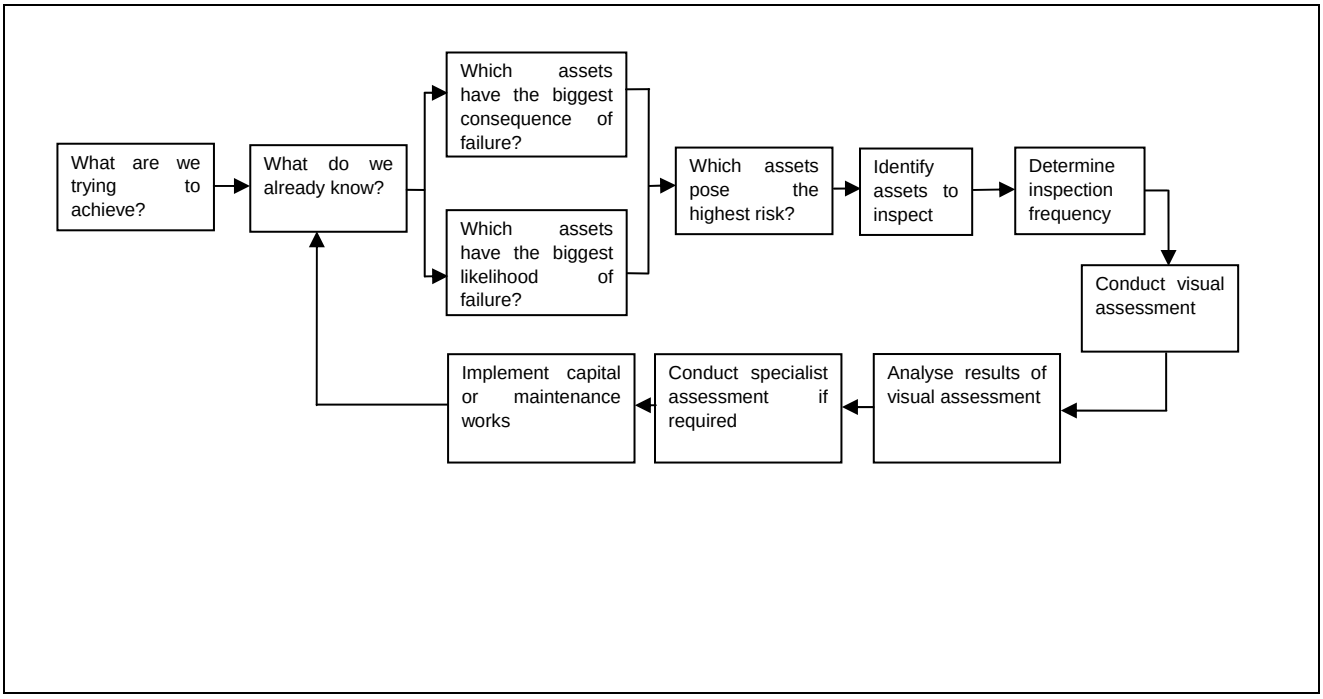
To determine which defects should be repaired and to prioritise this work, the asset manager needs a clear understanding as to:

- What is the objective of the assessment?
- What are the consequences of the asset failing unexpectedly?
- What is the likelihood of the defect worsening and on what timescale?
- What is the future demand on this asset?

2.3.2 How to develop a Visual Assessment programme

The generic process for developing a Visual Assessment programme is outlined in Figure 2-1. Usually this will be developed by the asset manager with input from the plant manager or plant operator.

Figure 2-1 – Generic process for developing a Visual Assessment programme



The individual tasks described in the diagram are summarised below.**What are we trying to achieve?**

- understand general condition;
- identify condition of specific assets;
- compare present condition with past condition; and
- plan remedial works.

What do we already know?

- what inspections have previously been conducted?
- what is the maintenance and repair history?

Which assets have the biggest consequence of failure?

- which systems and components are critical?
- what would happen to nearby communities if the asset(s) failed?
- how easy is it to repair?

Which assets have the biggest likelihood of failure?

- what buildings or structures are made to designs that show poor performance?
- what buildings or structures are subjected to unusually high or unusually low use??
- which buildings or structures have a history of failure.?

Which assets pose the highest risk?

- risk is defined as the product of consequence and failure

Identify assets to inspect

- Even in a smaller plant it might be easier to look at one type of asset in one go and check another type of asset the next time – eg in one visit check all of the pumps, and in the next check all the buildings.
- Even experienced inspectors often work as a team and each pick one class of asset to check – eg electrical plant, civil structures, mechanical components. In a larger plant, it might be useful to pick priority assets and concentrate on them.

Determine inspection frequency

The inspection frequency should take account of:

- the need to provide information for asset management purposes;
- recommendations from earlier assessments;
- the opportunity to get to the site;
- other planned assessments;
- cost of inspection; and
- any disturbance caused by inspection.

Conduct visual assessment

Visual Assessment only provides a view of the accessible outside faces of the structures. Therefore consideration needs to be given to:

- Cleaning of the structures prior to visual assessment. This helps expose the actual surface of the structures, but can destroy useful information.
- If the condition of the asset beneath the surface is of interest, then specialist assessment may be needed. These are usually more expensive and time consuming so will be conducted less often. Visual assessments may be conducted between times.
- How and when to inspect areas that are hazardous – this could simply require waiting until a particular part of the plant or process is inactive so that the hazard is not present, or it may require a major specialist assessment.

Often a visual assessment will be used to identify whether a specialist assessment is needed.

Analyze results of visual assessment

- The primary purpose of a visual assessment programme is to determine the present condition of the assets. This information can also be used to build up a record of asset condition over time and to identify whether any capital improvements or maintenance works are required to maintain or improve the required levels of service.
- The analysis may identify a need for additional or specialist assessment.
- Analysis of the results of the visual assessment will usually be conducted by experienced engineers or by asset management specialists.
- The level and type of analysis require will depend on the objectives of the assessment programme as indicated in the examples below. In all cases, however, it is important to check that the data is consistent – this means that when different people assess the same asset they should give the same grading.

The following table summarises some common analysis approaches.

Purpose of assessment	**Recommended Analysis**	**Comments**
To identify general condition of assets for long term planning	• Condition grading • Determine trends in condition • Identify assets that need urgent attention • Determine longer-term asset management strategy	Trends can be obtained by comparing assessments made on the same asset over time or on sets of similar assets with different service histories.
To identify the condition of critical assets	• Ensure criticality ratings are current and robust – conduct criticality review • Condition grading by experienced engineer or asset specialist to determine remaining life and failure modes of critical assets. • Develop an end-of-life management strategy based on above	Criticality can vary considerably between different individual assets and is influenced by external factors as well as asset condition. Formal criticality assessment and periodic review are recommended.
To identify the type of corrective maintenance needed to restore or maintain agreed levels of service.	• Consider specialist assessment – eg by materials specialist, structural engineer etc. • Experienced engineer or asset specialist determines works required to restore or maintain agreed levels of service. • Determine intervention options and develop management programme.	Intervention actions should take account of the present condition, the consequence of failure and the effectiveness of the remedial works.
To provide supporting input to the AMP or LTCCP	• Relate performance and condition to Level of Service requirements. • Provide robust data that will withstand audit.	The agreed levels of service may vary between different local authorities and between different communities within the same local authority

Conduct specialist assessment if required

- Visual assessments are often used to identify if there is a need for a specialist assessment
- Specialist assessments are described in Section 1.4.3.

Implement capital or maintenance works

- The visual assessment and any specialist assessment may identify a need for capital or maintenance works.
- The capital and maintenance works will usually be conducted under a separate contract.

2.4 Grading analysis

The Grades used here are based on those in the NZWWA Asset Condition Grading Manual, but have been modified so that the recommended actions can be linked to the planning documents used by most New Zealand Local Authorities.

Grade	Classification	Action	Description
1	Very Good	No Action required	New or near new condition Some wear or discolouration but no evidence of damage. Can include repaired assets where the repair is as good as the original.
2	Good	Monitor to see if there are changes	Deterioration or minor damage that may affect performance. Includes most repaired assets.
3	Moderate	Consider specialist assessment.	Clearly needs some attention but is still working. Structure in need of repair. Includes repaired where the repair is deteriorated.
4	Poor	Get specialist assessment.	Either not working or is working poorly because of damage or deterioration. Condition or structure is poor or structural integrity in question.
5	Very Poor	Replace or repair	Needs urgent attention.

The table below indicates the typical timescale for condition-related actions on longer life assets with a design life of 50 or more years (eg most civil structures) and shorter life assets, typically with a design life less than 20 years (eg mechanical and electrical assets and coatings).

Grade	Classification	Action	Timescale for longer life assets	Timescale for shorter life assets
1	Very Good	No Action required	No action needed within 20 years.	No action needed within 10 years
2	Good	Monitor to see if there are changes	Some action needed within 20 years	Some action needed within 10 years
3	Moderate	Consider specialist assessment.	Some action needed within 10 years	Some action needed within 3 years
4	Poor	Get specialist assessment or repair.	Action needed within 3 years	Action needed within one year
5	Very Poor	Replace or repair	Action required within one year.	Action needed more immediately

The table shows that asset grade is related to remaining life or to the time when remedial action – maintenance, repair or replacement - is needed, but the link is not always exact. Some assets change gradually and take many years to change from one grade to another, while others can jump rapidly from one state to another.

For example, steel usually takes time to progress from surface rusting to perforation and then on to more severe failure, but many plastics can remain in good condition for many years and then suddenly leak and break over a few days.

Assets that take a long time to change from one state to another can be more difficult to assess because the difference between an asset at the worse end of Grade 3 and the better end of Grade 4 could be quite small. However, because it takes a longer time to change from one state to the other, there is usually time to confirm this in another inspection.

Other assets can suddenly change from one state to another. They are usually easier to grade, because the time in the grey area between different grades is very short.

These action periods shown above tie in loosely with typical planning periods covered in various local authority plans – for example, asset management plans provide reasonably detailed programmes over a 3 year period and less detail over a 10 year period, so in most cases, work on a Grade 4 asset might be expected to be completed within the life of the present asset management plan.

If an assessment showed a significant change in the number of assets in Grade 4, for example, this would be important because it may show that there will be a problem in meeting agreed levels of service within the budget of the present plan.

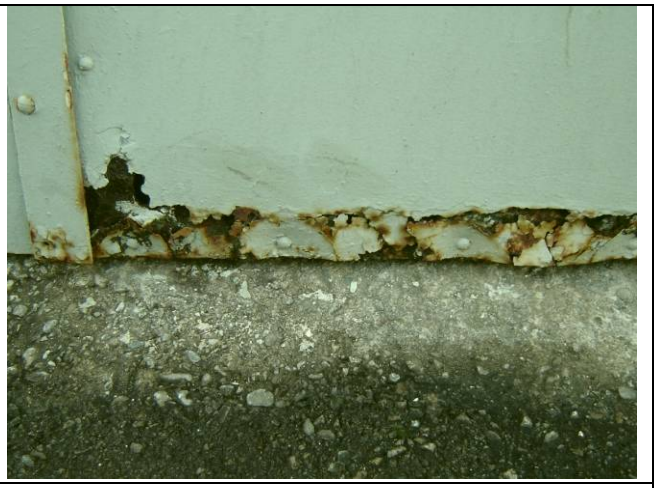
2.5 Reporting

2.5.1 Reporting by exception

Because of the variety of structures considered and the range of components and materials used, it is rarely practical to provide a comprehensive visual assessment report on all assets. This favours reporting by exception.

Reporting by exception focuses attention on components and tasks that need the most attention. Usually, this will be a part or component that is in worse condition than the rest, but it could be something that is in unusually good condition for its age or operating conditions.

The key point is to pick out anything that stands out, especially if it is in worse condition than the rest. The images below show an example of reporting by exception. The doors are generally in good condition but there is severe corrosion at the bottom. In this case, attention is drawn to the worst-affected area even though it only makes up a small part of the door.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>General view of painted steel doors showing the typical condition.</td><td>Localised corrosion at the bottom of the painted steel doors.</td></tr>
<tr><td colspan="2">Example of reporting by exception –
The doors are generally in good condition, but parts show severe corrosion.</td></tr>
</table>

2.5.2 Intervention conditions

An intervention condition is a condition at which some action should be taken. These actions can range from choosing to:

- do nothing;
- monitor something to see if it changes;
- call in a specialist to check the condition;
- repair a defect;
- replace or rebuild an asset; or
- reconfigure the entire system.

More immediate action may be needed where safety, security or public health is at risk.

The fact that the decision is made at the right time and by the right people is often more important than the action itself. This is because the right action can be influenced by outside factors, such as a planned upgrade in the near future, whether there is a backup system, how much money is available or the effect of the component going wrong.

Where possible, intervention conditions should be set so that work can be initiated in time to prevent avoidable expenses or preventable damage to the plant.

Examples of different materials and structures in varying stages of decay are shown in Section 3.

3 CONDITION EXAMPLES

This section provides example images of assets in different condition grades. The condition grades have been based on the NZWWA Infrastructure Asset Grading Guidelines with the following changes:

These examples cannot cover every type of asset in every material in every condition grade. Examples are therefore provided for:

- common types of materials in varying stages of deterioration to provide a guide to describing the state of various structures; and
- common types of structures to provide examples of how to report on exceptions, and how to describe groups of assets. As noted in Section 1.1.5, the structures covered here are structures whose condition can be assessed visually and the headings are based on the asset condition tables in the previous NZWWA Condition Grading Manual.

These examples are expected to cover most cases. If an asset does not fit one of the categories, the first thing should be to see if it is close enough to one of the examples here, but it may be necessary to get the asset assessed by an appropriately skilled and experienced specialist.

Materials covered are:

- concrete;
- wood;
- metals;
- plastics; and
- coatings (non-metallic coatings and metallic coatings)

Assets covered are:

- manholes and other inspection ports and points;
- surface operational assets (civil assets and structures);
- surface operational assets (electrical and mechanical components);
- buildings (eg pump station housings, storage sheds), including general site issues relating to access, security and appearance;
- civil works (including reservoirs, tunnels and pipe bridges); and
- above-ground pipework and valves.

3.1 Condition of different types of materials

The following images provide examples of different materials in different conditions. Not all of the condition grades listed have a photograph and some interpretation may be needed to assign a grade.

Section 3.2 contains examples of different types of structures and should be used in conjunction with this Section on materials.

3.1.1 Concrete

Most concrete structures are made of reinforced concrete which contains steel. The main features of interest are holes or breaks in the concrete and evidence of damage to the steel reinforcement.

Feature	**Suggested action**	**Comment**	**Recommended Grade**
No damage or deterioration	None	Includes new structures	1
Staining Surface deposit only	No action		1
Staining Actual staining of material	Monitor	Could be from rusting reinforcement	2
Cast- in voids	Monitor	May reduce the strength, often associated with reinforcement corrosion.	2
Cracking No evidence of leakage	Monitor	Cracks in concrete can self-heal	2
Corroded Surface softening Erosion	Specialist assessment	Could stay the same or get worse.	3
Cracking Evidence of leakage	Specialist assessment	Could heal, stay the same or get worse.	3
Spalling reinforcement not exposed	Specialist assessment	Weakens concrete and can expose reinforcement	3
Cracking Currently leaking	Specialist assessment	Needs repair	4
Exposed reinforcement, Loss of material	Specialist assessment	Will need repair	4
Major cracking, Major leakage, Major loss of material Structure looks unstable Corroded reinforcement Failed	Specialist assessment	Needs urgent attention	5

	Cast in voids in concrete. Grade 2
	Cracking. No evidence of leakage Grade 2

	Corroded concrete Grade 3
	Cracking Evidence of leakage Grade 3

	Actual staining of the material Grade 2. Exposed reinforcement, Loss of material Grade 4 The spalled area appears to have shallow concrete cover.
	Cracking. Currently leaking Grade 4

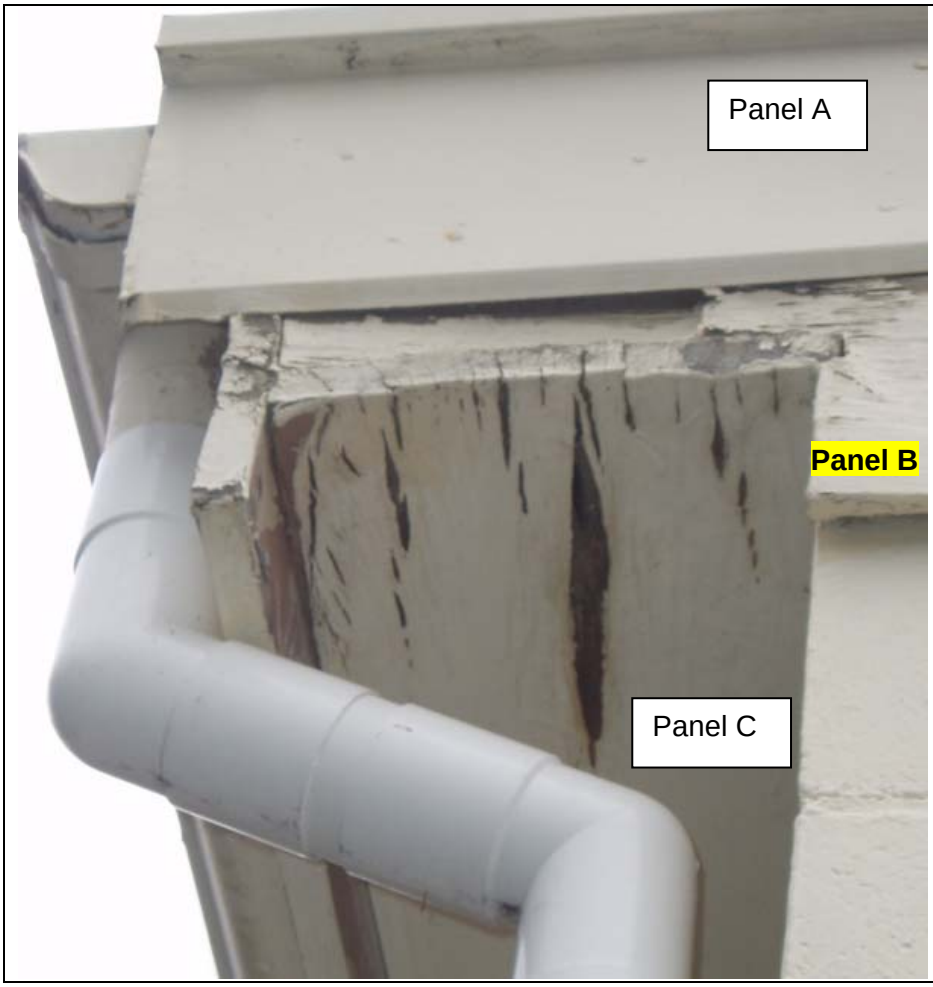
	Major loss of material Corroded reinforcement Grade 5
	Major loss of material Failed Grade 5

	Major cracking Grade 5

3.1.2 Wood

Wooden structures include wire-wound tanks or buildings, or individual components such as doors, window frames or covers. Many are painted. Features of interest mainly relate to holes, breaks or rot in the wood and evidence of damage to paintwork.

Feature	Suggested action	Comment	Recommended Grade
Sound	No action	No action required	1
Surface staining or discolouration – normal site	No action	No action required if surface discolouration only	1
Holes – not water holding area	Monitor	May need repair.	2
Cracking No evidence of rot	Monitor	May reduce the strength but can sometimes have no effect.	2
Warping – not water holding area	Monitor	Could stay the same or get worse.	2
Surface staining or discolouration – high visibility site	Cleaning or repainting	Action depends on client criticality requirements	3
Cracking Evidence of rot	Specialist assessment	Rot always needs inspection or replacement since it can spread	3
Damaged or loose fixings – operational issue	Repair or replace	If the fixing prevents the component operating (eg loose or missing hinge) it is Grade 4.	4
Cracking Evidence of rot Loss of material	Specialist assessment		4
Holes – water holding area	Urgent repair	Needs repair if threat to water quality	5
Warping – water holding area	Urgent repair	Needs repair if threat to water quality	5
Damaged or loose fixings – water holding area or safety issue	Urgent repair	Needs repair if threat to water quality or safety	5
Major rot	Specialist assessment	Needs urgent attention as rot can spread	5
Broken or clearly failed	Repair or replace	Needs urgent attention	5



Vertical Panel A
Sound
Grade 1

Vertical Panel B
Cracking
No evidence of rot
Grade 2

Horizontal panel C
Cracking
No evidence of rot

Grade 2

	Warping Grade 2 if not a water containing structure. Grade 5 if a water containing structure
	Cracking Evidence of rot Grade 3. The sunken area around the crack shows it is probably rotting.

	Rotted and weathered wood panel. Grade 4
	Major rot Grade 5

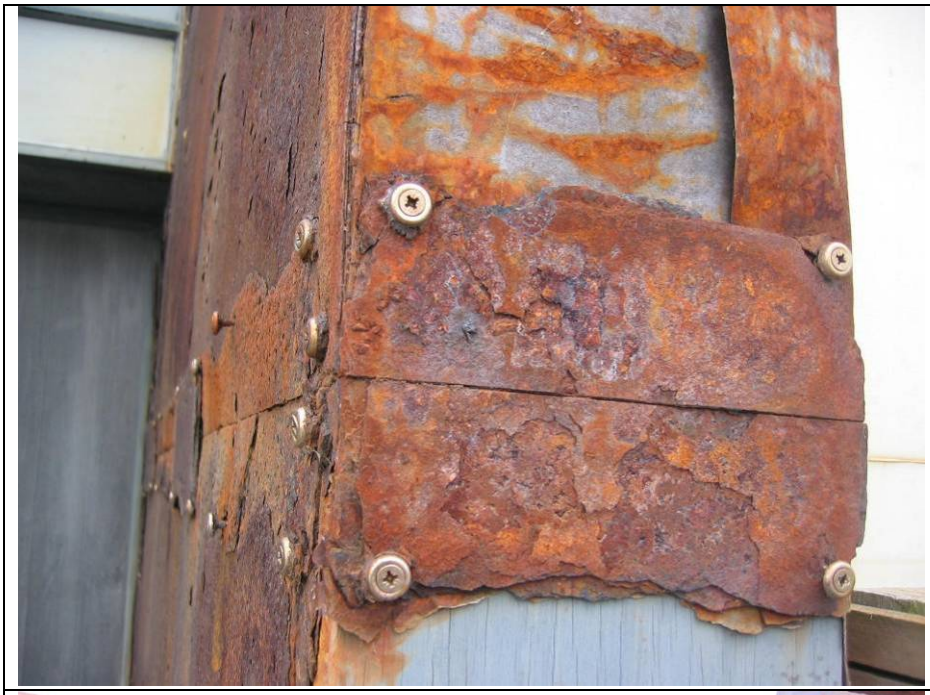
	Major rot Broken or clearly failed Grade 5

3.1.3 Metals

Most metal structures are steel with a protective coating (usually painted). Some aluminium, copper, lead and stainless steel components are left in a natural finish, as is the zinc coating on galvanized steel. Features of interest mainly relate to the build up of rust on steel (or its equivalent in other metals) and the resulting loss of material, any holes and the damage to the coating.

Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new structures	1
Surface staining or discolouration Surface rust	Monitor	Will need cleaning or repainting in future	2
Deformed – not water holding area	Monitor	Could stay the same or get worse.	2
Rusting affecting more than surface	Cleaning or repair		3
Holes and perforation	Repair	May reduce the strength but can sometimes have no effect.	3
Substantial flaking rust	Repair or replace		4
Damaged or loose fixings – operational issue	Repair or replace	If the fixing prevents the component operating (eg loose or missing hinge) it is Grade 4.	4
Deformed – water holding area	Urgent repair	Needs repair if threat to water quality	5
Damaged or loose fixings – water holding area or safety issue	Urgent repair	Needs repair if threat to water quality or safety	5
Severe corrosion Extensive perforation, Substantial metal loss Missing or clearly failed	Repair or replace	Needs urgent attention	5

Note: Galvanized steel is covered separately in Section 3.1.5.

	Substantial flaking rust Grade 4
	Substantial flaking rust Grade 4

	Severe corrosion Extensive perforation Grade 5
	Severe corrosion Extensive perforation, Substantial metal loss Clearly failed Grade 5

Stainless steel

Stainless steels resist corrosion better than normal steels but are not immune to it. Stainless steels typically corrode worst under deposits or in crevices (for example between washers and bolts or at joints). These locations are difficult to see, and rust-like staining, especially near a mechanical joint may warn of crevice or pitting corrosion problems. Stainless steel is affected by salt spray and geothermal conditions.

Tea-staining is a general brownish surface discolouration of little consequence. More major staining should be checked as it could be an indicator of pitting or crevice corrosion.

	**Stainless steel** Surface staining or discolouration Grade 2

3.1.4 Plastics

Plastics are used in a number of applications- common ones include fibreglass tanks and pipes, PE or PP tanks, PE, PP or PVC pipes. Most plastics do not corrode in normal use, but they are damaged by chemical attack, overheating, ultraviolet light (sunlight) and by physical damage.

Many plastics lose their surface shine after a few years – a process often known as chalking because the surface takes on a white powdery appearance. Chalking is often only a surface effect but severe discolouration, blistering or surface cracking is likely to indicate potential failure.

Feature	**Suggested action**	**Comment**	**Recommended Grade**
No damage or deterioration	None	Includes new structures	1
Surface staining or discolouration	No action	No action required if surface effect only	2
Holes, splitting or perforation - not water holding area	Monitor	May reduce the strength but can sometimes have no effect.	2
Deformed or misaligned – not water holding area	Monitor	Could stay the same or get worse.	2
Severe discolouration, cracking or blistering	Specialist assessment	Likely to progress to splitting or perforation	3
Damaged or loose fixings – operational issue	Repair or replace	If the fixing prevents the component operating (eg loose or missing hinge) it is Grade 4.	4
Holes, splitting or perforation - water holding area	Urgent repair	Needs repair if threat to water quality	5
Deformed or misaligned – water holding area	Urgent repair	Needs repair if threat to water quality	5
Damaged or loose fixings – water holding area or safety issue	Urgent repair	Needs repair if threat to water quality or safety	5
Major damage Major deterioration Major perforation, missing or clearly failed	Repair or replace	Needs urgent attention	5

	Surface staining or discolouration Grade 2 Surface deposit on interior pipework
	Surface staining or discolouration Grade 2 Deformed or misaligned – non-water holding area Grade 2 The misaligned may indicate uneven loading

	Holes, splitting or perforation - not water holding area Grade 2 Damaged plastic sheeting. Non-water holding area.
	Major damage Grade 5 Melting damage

	Major damage Grade 5 Surface scoring
	Major deterioration Grade 5 The pipe was subjected to chemical attack

3.1.5 Coatings

Coatings include paint and specialist coatings and galvanizing (which is a form of zinc coating). Many coatings are based on some form of plastics – they do not corrode in normal use, but they are damaged by chemical attack, overheating, ultraviolet light (sunlight) and by physical damage. Coatings often show a dulled or chalky surface before they start to crack and split.

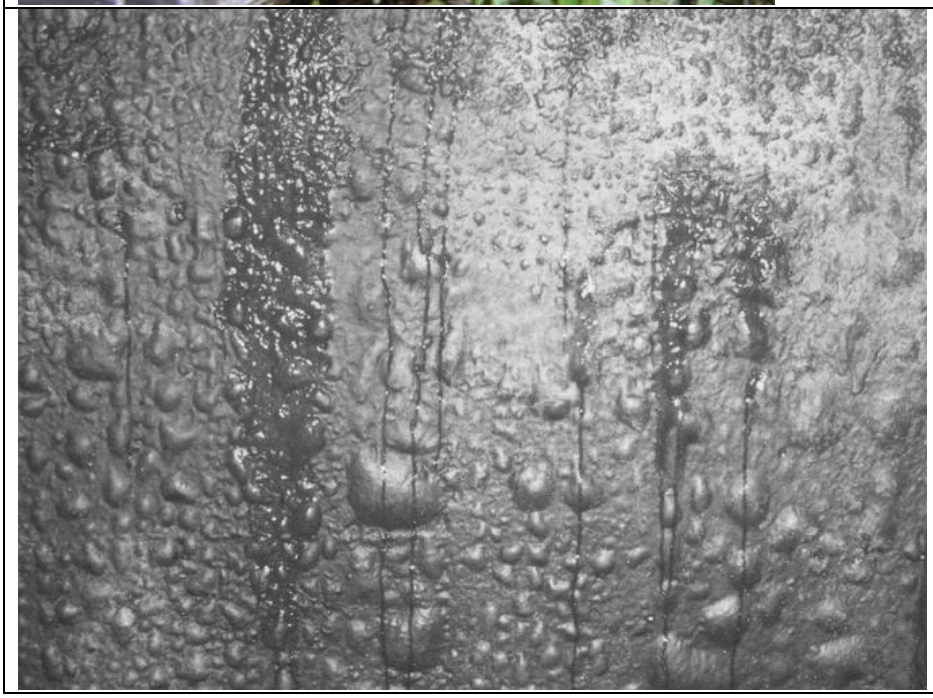
Blisters warn of corrosion beneath the coating, and splitting, cracking or other holes in the coating can allow the steel to rust. Since rust occupies more space than steel, the volume increase can force the surrounding coating from the metal, so the corrosion spreads outwards.

Non-metallic coatings

Most non-metallic coatings are bitumen, paint or polymer coatings. Evidence of rusting under coatings – including blistering - should be viewed as serious, even when the coatings are intact.

Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new structures	1
Minor surface staining, minor wear or discolouration	Monitor	Action required if condition changes	2
Major surface staining, major wear or severe discolouration,	Cleaning or painting	Action depends on client criticality requirements	3
Damaged or incomplete coating, but surface not exposed	Repair	Protection to underlying material is reduced.	3
Cracking or blistering	Specialist assessment	Usually indicates corrosion or deterioration under coating	3
Incomplete coating, coated material surface exposed and shows deterioration	Specialist assessment	Condition of coated component should be checked.	4
Split or detached coating, perforation or major deterioration of coated material, Coating missing or clearly failed	Repair or replace	Needs urgent attention	5

	Aged but still intact Grade 2 The factory-applied asphaltic coating is over 80 years old
	Major surface staining, major wear or severe discolouration. Grade 3

	Damaged but still covers pipe coating Grade 3
	Blistered coating Grade 3

	Incomplete coating, coated material surface exposed and shows deterioration Grade 4
	Incomplete coating clear evidence of damage to the material under the coating Grade 5

Split and detached coating,
Major deterioration of coated material,

Grade 5

The lower image shows a detail of the split coating exposing the pipe. Grass is growing between the coating and the pipe.

This is a PE coated steel pipe bridge.

Galvanized steel

Galvanized steel has a protective zinc coating. Where there is a breach of the coating, the zinc will corrode to protect the steel. The exposed steel may suffer some surface rusting but will not corrode to any great extent until the break in the coating is around 8 to 10 mm across.

Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new structures. Angular features on the surface known as spangles may be visible.	1
Surface staining or discolouration – (not rust staining)	None		1
Surface rust staining	Monitor	Action only required if condition changes	2
Minor damage to coating - surface not exposed	Monitor	Action only required if condition changes	2
Incomplete coating, exposed surface shows surface rusting only	Monitor	Patch repair of zinc coating may delay further rusting	2
Incomplete coating, exposed surface shows minor deterioration	Specialist assessment	Patch repair of zinc coating may delay further rusting	3
Incomplete coating, exposed surface shows major deterioration	Specialist assessment	Patch repair of zinc coating may delay further rusting	4
Coating largely consumed or clearly failed. Perforation or extensive loss of underlying metal.	Repair or replace	Needs urgent attention	5

	Incomplete coating, exposed surface shows surface rusting only Grade 2
	Incomplete coating, exposed surface shows surface rusting only Grade 2 (impact damage)

	Incomplete coating, exposed surface shows minor deterioration Grade 3
	Coating largely consumed or clearly failed. Perforation or extensive loss of underlying metal. Grade 5

3.2 Condition of different types of structures

The following images provide examples of different structures in different conditions. Not all of the condition grades listed have a photograph and some interpretation may be needed to assign a grade.

Section 3.1 contains examples different types of materials and should be used in conjunction with this Section.

3.2.1 Manholes and inspection covers

Manholes and their surrounds can break or corrode. Settlement or incorrect setting can leave the covers uneven. The examples below are mainly of covers for smaller chambers but they apply equally well to larger covers.

The impact on safety is important, since a missing or damaged cover can present a variety of safety hazards, especially if covering a confined space or other hazardous area. The client criticality requirements are therefore particularly important for these assets.

Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new structures.	1
Surface staining, discolouration or rusting	None	In high amenity areas might need repainting	1
Cover uneven or corroded but not presently a safety hazard.	Monitor	Will need repair or resetting if it becomes unstable, and urgent repair or resetting if it becomes unsafe.	2
Cover displaced, or unstable but not presently a safety hazard	Replace or repair and monitor	Will need urgent repair or resetting if it becomes unsafe	3
Damaged surround but substantially functional and not presently a safety hazard	Replace or repair	Likely to progress if not addressed	4
Damaged cover but substantially functional and not presently a safety hazard	Replace	Likely to progress if not addressed	4
Severe corrosion or damage, missing or safety hazard.	Replace	Safety hazard - needs urgent attention	5

	Cover uneven or corroded but not presently a safety hazard. Grade 2
	Damaged surround but substantially functional and not presently a safety hazard Grade 4

	Damaged cover but substantially functional and not presently a safety hazard Grade 4
	Cover missing or safety hazard. Grade 5 **Note**: Urgent attention is needed to replace cover

3.2.2 Surface operational assets - Civil structures

Surface operational assets cover a wide range of assets including water and stormwater intakes and outlets and overflows. When these are in public areas, the impact on safety is important, since they may connect to a confined space or other hazardous area. The client criticality requirements are therefore particularly important for these assets.

Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new structures.	1
Surface staining or discolouration	None	May need repainting if a high profile or high amenity site	1
Deterioration or damage that presently has little effect on performance and not presently a safety hazard	Monitor	Likely to change in service or to happen again	2
Damage that may have some effect on performance but substantially functional and not presently a safety hazard	Replace or repair	Likely to progress if not addressed	3
Damage likely to affect function but not presently a safety hazard	Replace or repair	Likely to progress if not addressed	4
Severe corrosion or damage, does not work, missing or safety hazard.	Replace	Needs urgent attention	5

Minor damage to grill.

Deterioration or damage that presently has little effect on performance and not presently a safety hazard

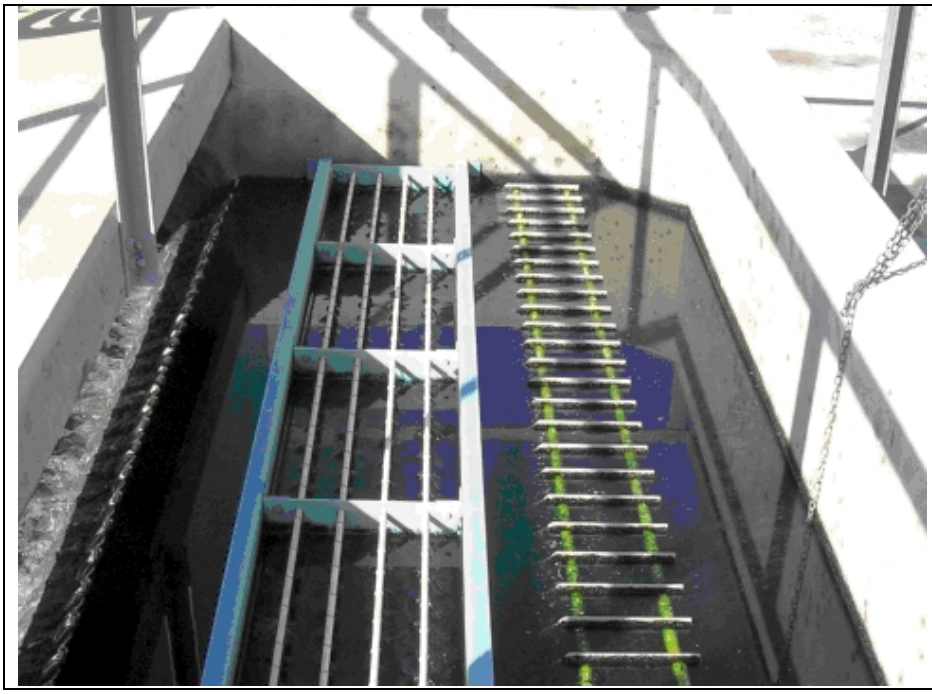
Grade 2

		Wooden sluice gate. Does not work Grade 5

3.2.3 Surface operational assets - Electrical and Mechanical Plant

This covers a wide variety of assets including control gates and valves, pumps and motors, telemetry and lighting.

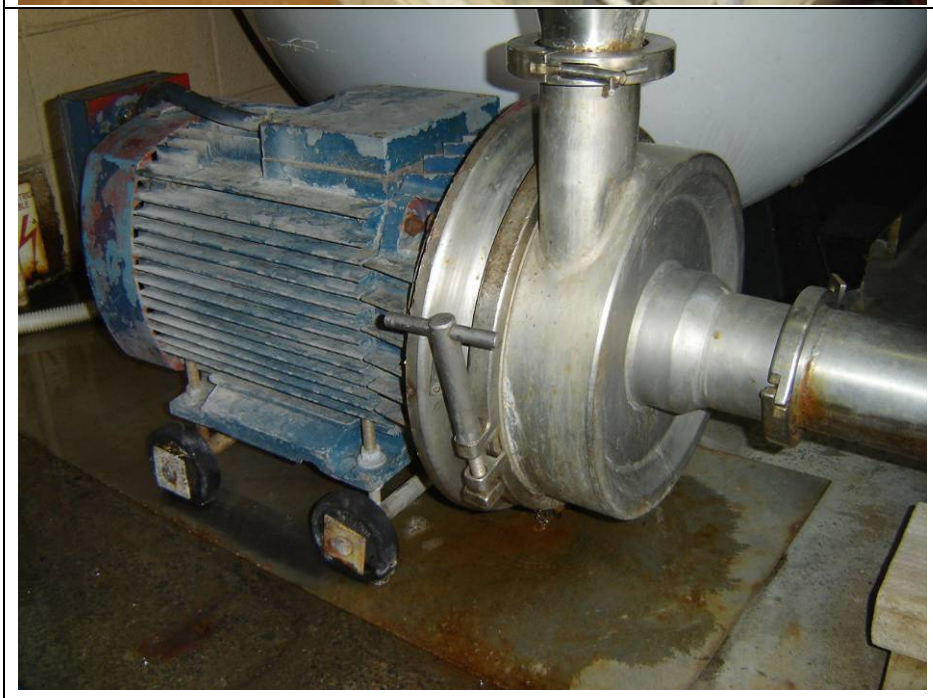
Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new components and structures	1
Surface staining or discolouration	None	Might need cleaning or repainting if high amenity site	1
Deterioration or damage that presently has little effect on performance and not presently a safety hazard	Monitor	Includes minor surface rusting, deterioration of coating	2
Deterioration or damage but substantially functional and not presently a safety hazard	Replace or repair	Likely to progress if not addressed	3
Deterioration or damage likely to affect function but not presently a safety hazard	Replace or repair	Likely to progress if not addressed	4
Severe corrosion or damage, does not work, missing or safety hazard.	Replace	Needs urgent attention	5



Brush clarifier

No damage or deterioration.

Grade 1

	**Dosing pump set** No damage or deterioration Grade 1 **Associated pipework** No damage or deterioration Grade 1
	**Pump** Deterioration or damage but substantially functional and not presently a safety hazard Grade 3 **Stainless steel pipework**. Deterioration or damage that presently has little effect on performance and not presently a safety hazard Grade 2

	**Indoor control cabinet** No damage or deterioration Grade 1
	**Outdoor control cabinet** No damage or deterioration Grade 1

Outdoor control cabinet.

Deterioration or damage but substantially functional and not presently a safety hazard

Grade 3

3.2.4 Buildings, grounds and security

Buildings are structures to provide a secure, weather proof housing for equipment or personnel. This heading also covers access, site security and safety.

It is often difficult to assign Condition Grades purely on physical condition for access, site security and safety, as the required condition is strongly influenced by performance requirements. The client's definitions of what is a critical defect are therefore particularly important when assessing these.

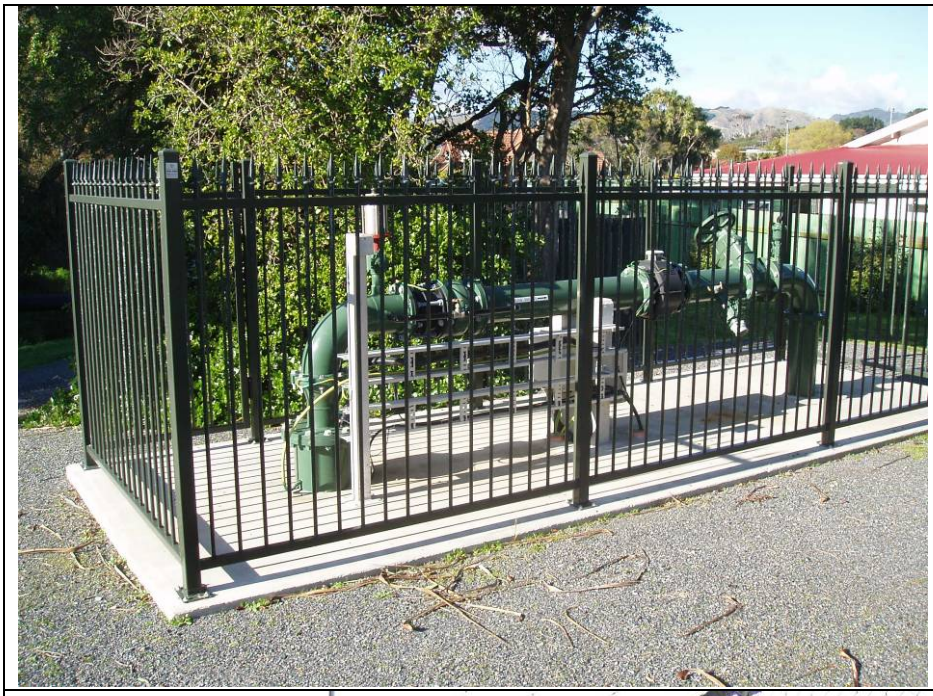
> **Note**: Commercial and residential buildings should normally be assessed using documents such as the NAMS Property Manual. Property management documents are usually focussed on developing detailed maintenance programmes rather than condition and may include more detail than is required for condition assessment.

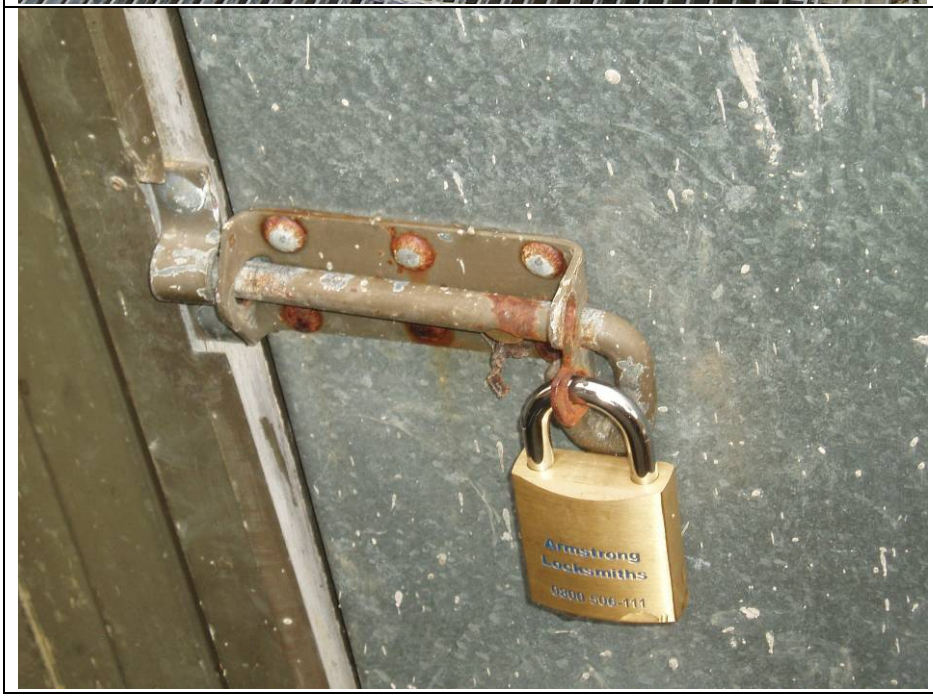
Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new components and structures	1
Surface staining or discolouration or other visual defect	None	Might need action if high profile or high amenity site	1
Deterioration, damage or defect that presently has little effect on performance and not presently a safety hazard	Monitor	Includes minor surface deterioration, future security issue or grounds in poor condition	2
Deterioration, damage or defect but substantially functional and not presently a safety hazard	Replace or repair	Likely to progress if not addressed. Includes parts of grounds in poor condition that affect access to plant. Sub-standard security issue or equipment that is still functional.	3
Deterioration, damage or defect likely to affect function but not presently a safety hazard	Replace or repair	Likely to progress if not addressed. Includes grounds in poor condition that affect access to plant or its operation. Sub-standard security issue or equipment that has reduces effectiveness.	4
Severe corrosion, damage, or defect, does not work, missing or safety hazard.	Replace or repair	Needs urgent attention for one or more reason.	5

Buildings and structures often need to be assessed by components – all the windows could be assessed separately from the doors, the walls and the roof.

Grounds covers a wide range of miscellaneous issues including whether paths, tracks and walkways are usable or trees kept away from fences and overhead cables. There may be considerable overlap with security which can address secure doors and hatches for water storage areas and safe access within the site.

	**Buildings** No damage or deterioration Grade1
	**Building (Roof)** Deterioration or damage likely to affect function but not presently a safety hazard Grade 4

	**Grounds (security)** No damage or deterioration. Grade 1 **Grounds (access)** No damage or deterioration Grade 1
	**Grounds (access – stairs and handrail)** No damage or deterioration Grade 1 **Grounds (security – fence)** No damage or deterioration Grade 1

	**Grounds (security - cover)** Surface staining or discolouration or other visual defect Grade 1
	**Grounds (security - bolt)** Deterioration, damage or defect that presently has little effect on performance and not presently a safety hazard Grade 2

	**Grounds (security – fence and gate)** Deterioration, damage or defect likely to affect function but not presently a safety hazard Grade 4 Fence and gate present, but fence does not enclose all of property
	**Grounds (security)** Severe corrosion, damage, or defect, does not work, missing or safety hazard. Grade 5. No door or window protection to a water storage area in an unfenced site.
	**Grounds (security)** Deterioration, damage or defect likely to affect function but not presently a safety hazard Grade 4. Door is missing but this is a non-critical area and the building is in a securely fenced site.

	**Grounds (security)** Severe corrosion, damage, or defect, does not work, missing or safety hazard. Grade 5 Hole in mesh large enough to let vermin into water storage area.
	**Grounds (security)** Severe corrosion, damage, or defect, does not work, missing or safety hazard. Grade 5 Gate with no fence leaves site visibly insecure.

Grounds (general)

Deterioration, damage or defect but substantially functional and not presently a safety hazard

Grade 3

The overgrown area increases the risk of damage to the pipe but the area is not trafficked and presents no immediate safety issues.

In a trafficked area, the trip hazard hidden pipe would be a safety issue – Grade 5

3.2.5 Civil works

Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new components and structures	1
Surface staining or discolouration or other visual defect	None	Might need attention if a high profile or high amenity site	1
Deterioration, damage or defect that presently has little effect on performance and not presently a safety hazard	Monitor	Includes minor surface deterioration and damage that has been successfully repaired or has fixed itself.	2
Deterioration, damage or defect but substantially functional and not presently a safety hazard Includes evidence of minor leaks.	Specialist assessment	Likely to progress if not addressed.	3
Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage.	Replace or repair	Likely to progress if not addressed.	4
Severe corrosion, defect or damage, active major leakage, missing component or safety hazard.	Replace or repair	Needs urgent attention for one or more reason.	5

Reservoir or tank

Surface staining or discolouration or other visual defect

Grade 2

There is evidence of cracking that appears to have self-healed.

No evidence of any active leakage.

	**Reservoir or tank** Deterioration, damage or defect but substantially functional and not presently a safety hazard Includes evidence of minor leaks. Grade 3 Minor leaks in structure
	**Reservoir or tank** Severe corrosion, defect or damage, active major leakage, missing component or safety hazard. Grade 5 Damaged roof allowing access to stored water The minor leaks in the structure would otherwise be Grade 3

	**Reservoir or tank** Deterioration, damage or defect but substantially functional and not presently a safety hazard Includes evidence of minor leaks. Grade 3 Cracking with evidence of leakage
	**Reservoir or tank** Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage. Grade 4 Cracks and active leaking.

Pipe bridge

Deterioration, damage or defect that presently has little effect on performance and not presently a safety hazard.

Grade 2

There is a minor casting defect on the concrete and some surface deposits but the pillar and metal fixture are essentially undamaged.

	**Pipe bridge** Deterioration, damage or defect but substantially functional and not presently a safety hazard Includes evidence of minor leaks. Grade 3 The span exceeds the recommended safe support span.
	**Pipe bridge** Deterioration, damage or defect but substantially functional and not presently a safety hazard Includes evidence of minor leaks. Grade 3 Bridge abutment cracked around bolt.

	**Pipe bridge** Deterioration, damage or defect but substantially functional and not presently a safety hazard Includes evidence of minor leaks. Grade 3 Cracking of support pillar
	**Pipe bridge** Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage. Grade 4 Exposed corroding reinforcement in pipe support column.

	**Pipe bridge** Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage. Grade 4 Hanger not supporting pipe and not vertical. Also, exposed corroding reinforcement in bridge.
	**Pipe bridge** Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage. Grade 4 The top plate is broken. The pipe is resting on the saddle.

3.2.6 Pipework and valves

This can include pipework inside or outside plants. It includes the pipes in pipe bridges but does not include the load carrying components of pipe bridges, which are covered in Section 3.2.5.

Feature	Suggested action	Comment	Recommended Grade
No damage or deterioration	None	Includes new components and structures	1
Surface staining or discolouration or other visual defect	None	Might need attention if a high profile or high amenity site	1
Deterioration, damage or defect that presently has little effect on performance and not presently a safety hazard	Monitor	Includes minor surface deterioration and damage that has been successfully repaired or has fixed itself.	2
Minor deterioration, damage or defect but substantially functional and not presently a safety hazard. Includes evidence of minor leaks.	Repair	Likely to progress if not addressed.	3
Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage.	Replace or repair	Likely to progress if not addressed.	4
Severe corrosion, defect or damage, active major leakage, missing component or safety hazard	Replace or repair	Needs urgent attention for one or more reason.	5

Pipes

No damage or deterioration

Grade 1

Plastic pipework in good condition.

	**Pipes** Surface staining or discolouration or other visual defect Grade 1 Assorted pipework in good condition but with some discolouration
	**Pipes** Deterioration, damage or defect that presently has little effect on performance and not presently a safety hazard. Grade 2 Repaired concrete pipe with no evidence of subsequent leakage. Despite initial appearances, it appears to be an effective repair.

	**Pipes** Minor deterioration, damage or defect but substantially functional and not presently a safety hazard. Includes evidence of minor leaks. Grade 3 The coating is no longer protective and the pipes are starting to corrode. The pipes are presently in reasonable condition but can be expected to get worse if the defect (lack of coating) is not put right.
	**Pipes** Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage. Grade 4 Cracked concrete pipe Although not actively leaking, leakage is almost certain. This would be Grade 5 if a potable water pipeline.

	**Pipes** Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage. Grade 4 Concrete pipe and chamber. Actively leaking. This would be Grade 5 if a potable water pipeline or if reliable access was a safety requirement.
	**Pipes** Severe corrosion, defect or damage, active major leakage, missing component or safety hazard Grade 5 Severely damaged pipe that has not been effectively repaired. The abutment is also in a similar condition.

	**Valves** Deterioration, damage or defect that presently has little effect on performance and not presently a safety hazard. Grade 2 Surface deposits on pipes and valves with no evidence of rusting or other problem.
	**Valves** Deterioration, damage or defect likely to affect function but not presently a safety hazard. Includes active leakage. Grade 4 Actively leaking valve

3.3 Other assets and components

It is not possible to cover every type of plant component or material in a manual like this so it is likely that non-standard plant and components or non-standard materials will be met from time to time. If plant contains non-standard components or materials and the condition is not obvious, it is best to take a photograph of the component and to label it as unknown condition.

The condition can then either be monitored by comparing the present state with the original image, or it can be checked later on by a specialist.

APPENDIX A MODEL SPECIFICATION

This section provides an example of model documentation for visual assessment contracts.

Purpose of contract

The purpose of this contract is to:

(Describe the purpose of the contract)

Scope of Works

The scope of this contract involves:

- Visual Assessment of above ground, accessible plant and buildings.
- Supporting checks not requiring specialist skills, knowledge or equipment.
- Confirming the presence and position of plant and equipment.
- Identifying the general condition of assets.
- Reporting the position of plant and equipment that is incorrectly positioned on the Clients plans.
- Locating major defects requiring immediate repair.

(Delete the items that do not apply)

Assets to be inspected

The assets to be inspected are:

- Shown on the attached plans.
- Listed on the attached schedules.
- Other (provide details).

(Delete the items that do not apply)

Issues to be aware of

Issues that the Asset inspection contractor needs to be aware of include:

(Provide details on the location and the Client's requirements if any of the following may impact upon the works)

Whether or not to clean assets prior to inspection.

Whether images are required of particular features or structures.

Assets that are suspected to be damaged or deteriorated.

Assets that are known to be damaged or deteriorated.

Aggressive or potentially dangerous contents.

Any special reporting requirements (eg to report all Grade 5 assets immediately).

Location and access to assets and plant.

Health and Safety Hazards

Health and Safety hazards at the site are described in the plant Operations and Maintenance manual.

(Provide access to the relevant manuals or list all hazards known by the Client.)

Specific additional hazards that may be encountered during a site inspection include:

(Add items to show all hazards known by the Client that specifically affect an inspection in addition to the normal operational hazards at the plant. These are anticipated to include access to parts of the plant, working at heights, and other risks associated with inspecting the plant)

Cleaning and preparation for inspection

Prior to assessment, the assets are to be:

- Fully cleaned to remove all foreign matter including grease, surface deposits, general debris and loose or flaking paint or surface coating. Staining and discolouration need not be removed.
- Fully cleaned to remove all foreign matter including grease, surface deposits and general debris. Loose or flaking paint or surface coating, staining and discolouration need not be removed.
- Lightly cleaned to remove loose surface deposits using brush, cloth or low pressure hose. If parts of the asset surface remain obscured, the Contractor is to notify the Engineer. The Engineer shall advise the Contractor whether to conduct further cleaning or to conduct an assessment of the incompletely cleaned assets.
- No cleaning is required prior to the visual assessment. The assets are visually assessed as is. If parts of the asset surface remain obscured, the Contractor shall report this in the assessment.

(Delete the items that do not apply)

Images

Images of the following are to be collected:

- Overall image(s) of the site sufficient to identify the individual assets assessed, either in a single image or a series of images. A marked plan or photograph will be acceptable.
- Arecord of overall condition of each asset class and exceptions as noted below:
    a. a record of major defects that justify a Condition Grade 4 or Condition Grade 5 in an asset that is otherwise in Condition Grade 1,2 or 3.
    b. a record of items that justify Condition Grade 1 or 2 in an asset that is otherwise in Condition Grade 4 or Condition Grade 5.
- The minimum still image size shall be <*Client to insert minimum size here*> Megapixels.
- Still images for ongoing monitoring shall be taken so as to match, as far as reasonably possible, any reference images provided for the site.

Video images

If video images are taken, these will be in addition to the imaging requirements stated above.

- The minimum video image size shall be < *Client to insert minimum size here* >.
- Video records shall be reported in < *Client to describe required video reporting format here>*

(delete this item if not required)

Critical defects requiring immediate attention

The Contractor shall notify the Engineer immediately on identifying any of the following defects:

(Client to list any critical defects for the asset inspected)

Quality assurance

The Client shall undertake auditing verification of the assessment at the following frequency:

- 5%
- Other (*Client to define frequency*).

Deliverables

The contractor is required to provide a record of assessment in the following format:

- Computer generated
- Handwritten
- With supporting still images
- With supporting video images.
- Marked up drawings or images of the site noting assets inspected.
- Schematic diagrams showing the locations of features and defects in the assets:

(Delete the items that do not apply)

Report information required

The following information is to be provided in addition to the fields specified in the General Specification (descriptions of these items are included in Section 2 of the Manual):

Job No. or order number of inspection

Client.

Contractor

Inspector.

Date of Data Entry.

Date of Assessment

Site Location

Description of which parts of the plant were assessed.

Weather during and immediately before assessment.

Comments.

Additional Information *(Client to specify).*

(Delete the items that do not apply)

Note: There is an example report in Appendix B.

APPENDIX B EXAMPLE REPORT

This section provides an example report for a visual assessment. Other formats may be used to meet specific client requirements.

Asset	Smalltown water treatment plant	**Asset ID**	11111
Date of assessment	31st February 2008	**Inspector(s)**	Jo Seymore and Joe Spotless
Description	Plant has an intake, settlement tank, filter, storage reservoir and pump house.		
Weather	Dry before and during inspection.		

Asset	Sub-asset	Description	Main condition	Exceptions
Intake		Concrete with stainless steel grill. Concrete sound, slight rust staining on grill.	Grade 1.	None
Settlement tank		Wooden. Minor leaks. No worse than last time (May 2007).	Grade 3	None
Filter		Concrete with painted steel parts. Repaired concrete still sound, but has cast-in holes.	Concrete Grade 2 Painted steel Grade 1	None
Storage Reservoir		Concrete. Leaking and moss growth. Needs checking.	Grade 4	none
Pump House				
	Building	Painted steel. Some weathering but generally good. Some local rusting near bottom of panels.	Grade 2	Local rusting Grade 4
	Access	Overgrown – difficult to get in.	Grade 3	None
	Security.	Fence Sound (Grade 1) Post rotting (Grade 3), and Gate hinge broken and lock missing (Grade 5).	Fence Grade 1 Post Grade 3	Gate Grade 5
	Pumps	Power cables clean with safety stickers. Pumps – paint chalky and split in places. Pump 1 sounds rough and one bolt missing from mounting.	Power cables Grade 1	Pump 1 Grade 4
Other				
	Telemetry mast	Freshly painted, looks sound.	Grade 1	None

Example report pictures and comments (Page 1 of 2)

Intake grill Stainless steel grill in good condition.	
Settlement tank Wooden tank showing minor leakage	

Example report pictures and comments (page 2 of 2)

Storage Concrete tank - leaking when inspected. Mould or moss growing near leak.	
Pump house Siding showing some weathering but no damage.	
Pump house Detail of siding showing local rusting at bottom of panel.	

APPENDIX C ASSESSING OTHER STRUCTURES

Although this manual has been written for visual assessment of structures that are accessible and visible in normal use, the approach can also be used when components that are normally inaccessible are exposed – eg when a tank has been drained for cleaning, or when a buried pipe has been exposed for scheduled works or for repair.

It should normally be possible to make an assessment of the apparent condition by referring to the examples provided in Section 3. In this example a buried pipe has been exposed so both the coating and pipe condition can be assessed.

Coating
Incomplete coating, coated material surface exposed and shows deterioration

Grade 4

Pipe
Minor deterioration, damage or defect but substantially functional and not presently a safety hazard. Includes evidence of minor leaks.

Grade 3

Note: Where a section of an asset is cut out as part of scheduled works or as part of a repair, the cut section should be kept and labelled so that it can subsequently be used for specialist condition assessment if required.

Note: Asbestos cement pipe and components requires special cutting and handling procedures (See the comments on Health and Safety in Section 1.3).