SEATON VALLEY STREAM UPGRADE: CASE STUDY OF IMPLEMENTING A CHANNEL UPGRADE ON MULTIPLE PRIVATE PROPERTIES

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ABSTRACT

The Seaton Valley Stream is the main watercourse draining the hills behind Mapua and Ruby Bay, across coastal flats beside the Mapua township to the Waimea inlet. The lower section of the stream is approximately 2.5km long and crosses multiple private properties with a number of culverts and driveways over the stream. It is also associated with some challenging drainage easements dating back to 1917, which afforded rights to the upstream property owners over the downstream section of drain in private property.

Our presentation will outline the key challenges and solutions in implementing the stormwater upgrade including:

- The consultation process with the multiple private property owners and the strategies to gain acceptance from the property owners.
- The lessons learned from the consenting process in a sensitive coastal environment.
- How to integrate the hydraulic design with landowner and consent constraints.
- How the infrastructure engineers and the policy planners worked in parallel to achieve the above.

KEYWORDS

Hydraulic modeling, Consenting, Landowner consultation, Culvert design and construction.

PRESENTER PROFILE

Denis is currently the Discipline Leader for the civil water design team across the MWH Asia Pacific Design unit. Denis has been active in stormwater and drainage projects for Tasman District Council since moving to New Zealand in 2004. Previously he has worked in Ireland and United Kingdom on a wide variety of water infrastructure projects. Denis holds a BE (civil), a MBA, is a chartered engineer CPEng (civil) and is a PMP qualified project manager.

David Stephenson has been an Utilities Asset Engineer with the Tasman District Council for six years. Prior to his asset management work with the Council, David has worked in a number of engineering consultancies, specialising hydraulic and hydrological modelling.

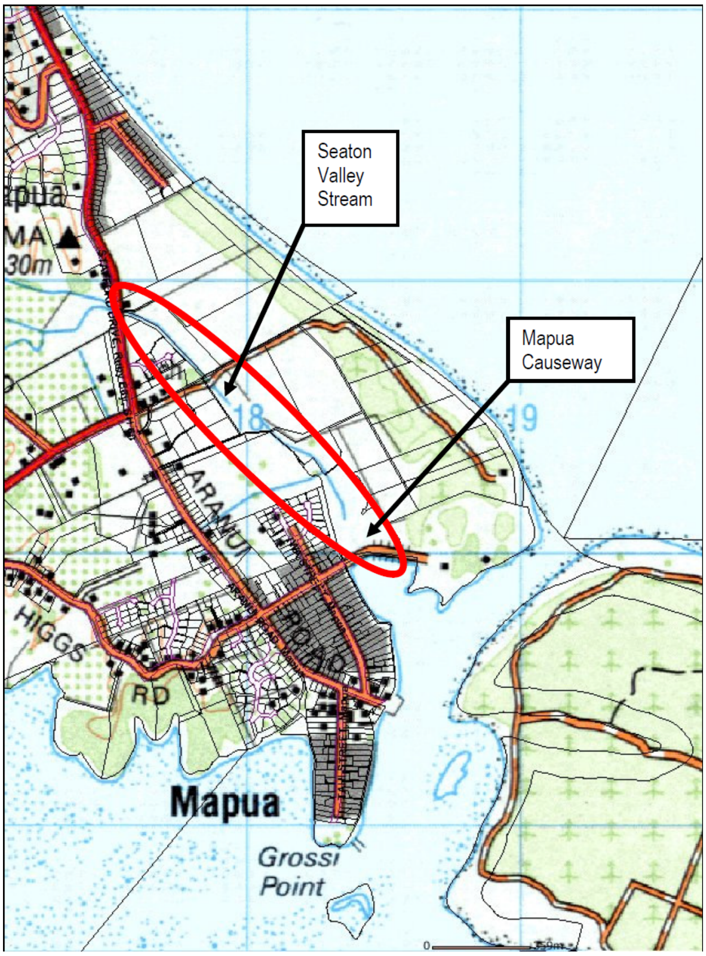
1 INTRODUCTION

Tasman district has been one of the fastest growing regions in New Zealand over recent years. This has led to increased development in rural residential areas such as Mapua. The Mapua township is approximately 15km west of Richmond and it is located in Tasman Bay.

The Seaton Valley Stream drains the upper reaches of the catchment and flows around the township to the estuary. The upper reaches of the catchment have become more developed over time, and there has been pressure to develop the lower reaches adjacent to the drain.

Tasman District Council committed to the upgrade of the Seaton Valley Stream in Mapua in 2007 as the result of development pressures in Mapua and the low level of service provided by the existing drainage network.

Figure 1: Location Map



2 CATCHMENT DESCRIPTION

The Seaton Valley Stream is the main drainage artery through Mapua and drains a total of 450 ha through into a tidal estuary. Figure 1 details the location of the stream relative to the estuary and surrounding urban Mapua.

The upper reaches of the catchment have a reasonable gradient while the lower reaches are very flat with a typical longitudinal gradient of 1 in 4,000. The catchment soils are a combination of Tahunanui sand and Rabbit Island gravel over the coastal flat area, and Mapua sandy loam on the rolling hills. In the lower catchment, the soils and gravels are underlain by soft estuarine sediments.

2.1 CATCHMENT FEATURES

The catchment generally has freely draining low-land soils on the hillsides and low-land, but these are affected by high local groundwater conditions in winter and spring.

The lower catchment originally consisted of coastal wetlands and sand dunes, and these were subsequently drained by the construction of the existing stream channel in the early 20^{th} century. The stream originally discharged directly into a northern arm of the Waimea Estuary, but this open connection was interrupted by construction of a causeway across the estuary in the 1950s.

Construction of this and other man-made features have affected the nature of the stream and associated floodplain and were significant considerations in the hydraulic design process.

2.1.1 NATURAL STORAGE AREAS

The waterway has two major flood storage areas which significantly affect stream flow and flood levels. The first one is located at the foothills of the catchment, upstream of an "Armco" culvert under the former State Highway 60 (SH60). (This was created by the construction of the SH60 culvert and causeway over a long time period). This storage area has a total area of 49 ha.

The second storage area is located immediately upstream of the estuary causeway. This storage area was created by the construction of the Toru Street causeway embankment in the 1950s to gain access to the peninsula during all tides. This property has subsequently become a very popular holiday camp ground. This lagoon had a total area of 120 ha.

Photographs 1 and 2: Upstream and downstream Toru Street causeway

2.1.2 EFFECT OF ROAD EMBANKMENTS

Both Stafford Drive (SH60) and Aranui Road (another significant local road) are constructed significantly higher than the surrounding ground level, and are close to floor levels in some dwellings. When pipeline drainage and culvert capacities have been exceeded in the past, the water levels upstream have risen to the level of the road (secondary flood paths) before the drainage capacity increases.

2.1.3 PRIVATE STOPBANK IN CATCHMENT

A series of private stopbanks are located in parts of the property upstream of the SH60 culvert. These were constructed in the late 1960s or 1970s by the landowners to protect part of this farm land from inundation by the waterway. These private stopbanks have the effect of reducing the available storage volume in the upstream storage area.

2.2 CULVERT RESTRICTIONS

The Seaton Valley Stream previously had four major culverts, which are detailed in the following table.

Table 1: Existing Culverts on Waterway

Culvert Number	Location	Size / Details
1.	Toru Street Causeway.	Twin 900mm diameter with partial depth timber flap gates.
2.	Private driveway to three residences.	Twin 900mm diameter culverts.
3.	Right of way to seven properties.	Triple 600mm diameter culverts with concrete splashover.
4.	State Highway 60 culvert.	2.4m high by 2.7m wide arched Armco culvert.

The majority of these culverts have a low capacity and were causing significant headloss at higher flows.

3 HYDRAULIC STUDY

MWH New Zealand Ltd was commissioned by Tasman District Council to develop an improvement strategy for the Seaton Valley Stream. The objectives of this study were substantially to:

- Provide a floodplain assessment of the low lying areas around Mapua and Seaton Valley Stream.
- Establish the levels of service provided by the existing system and identify critical floor levels relative to the levels of service.
- Create and calibrate a hydraulic model against a June 2003 flooding event.
- Provide flood hazard mapping of the existing and proposed development scenarios.
- Design an upgrade sequence that could provide 1 – 100 year ARI flood protection (including provision for climate change).
- Provide guidance to Council on managing the flood hazard risk that would remain after the upgrade.

3.1 HYDRAULIC MODEL

A hydraulic model of the stream and the storage areas was created using Mike 11 software. In total, 96 individual cross sections, 13 culverts and weirs and 11 branches were added to the model.

During the study, Council commissioned a LiDAR ground model survey and this provided greater clarity in assessing the storage volumes. The LiDAR data enabled 0.1m contouring to be generated which was critical in the production of the flood hazard mapping.

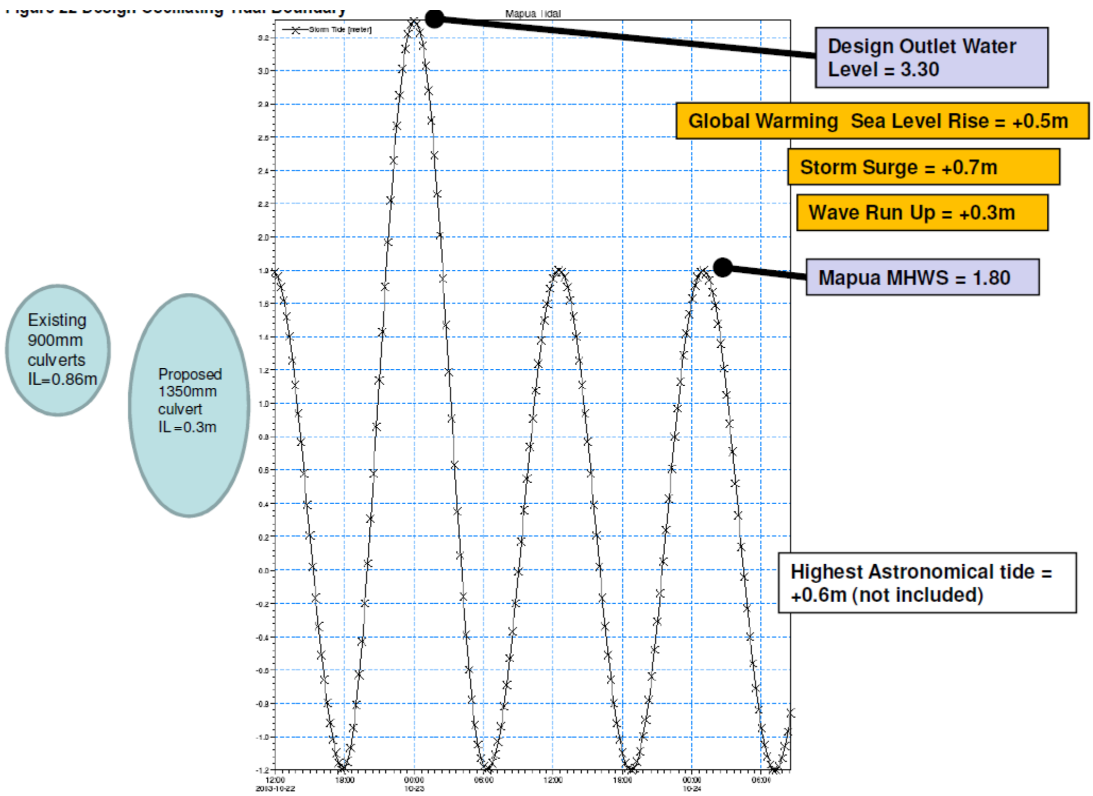
The channel friction loss coefficient was set to reflect farmland, orchards and straight, uncomplicated drainage alignments, and an initial water level in the system was set at the invert level of the causeway culverts (RL 0.86m). Hydrograph inflows entered the hydraulic model at logical cross sections. Oscillating tidal boundary conditions were established at the outlet cross sections, with the peak high tide design level coinciding with the peak rainfall intensity.

The peak design outlet water level of the estuary was set at 3.3m RL to account for the combined effect of wave run up, storm surge and future sea level rise from global warming. Figure 2 details the tidal oscillating boundary relative to the existing and new outlet culvert levels.

The critical model scenario simulated a 72 hour duration event, with a 36 hour initialisation prior to the start of rainfall (to develop a tidal effect), 24 hours of rainfall, and 12 hour simulation after the design rainfall stops to model estuary levels. In all cases, the peak top water level occurred prior to rainfall ending. This implies that the system response time is less than the 24 hour rainfall duration.

The hydraulic model also includes a small number of private tributary drains and associated culverts. Other branches were added to the hydraulics model based on the ground contour model in order to apportion catchment runoff inflow hydrographs and to approximate system storage volumes. Cross section top water levels were used in the preparation of flood extent maps.

Figure 2: Design Oscillating Tidal Boundary



3.2 CRITICAL FLOOD LEVELS

Floor levels of known flood-prone houses were surveyed to provide critical flood design levels for upgraded drainage elements. Floor levels in representative locations near to the main waterways were surveyed to give a spread of critical levels. The flood protection design standard adopted for the upgrade of drainage elements around the floodplain was 500mm freeboard between critical floor levels and peak water levels in a 100 year ARI rainfall event.

3.3 HYDROLOGY

A hydrological model for the catchment was created using HEC-HMS software. The curve number (CN) method rainfall loss methodology and the Clarkes Unit hydrograph runoff distribution method were used to produce runoff hydrographs for each sub catchment. Output hydrographs from the HEC-HMS model for individual and combined sub-catchments were entered into the Mike 11 hydraulic model at appropriate cross sections.

3.4 CONVERTING A RATIONAL MODEL INTO A DYNAMIC MODEL

Runoff hydrographs for a 5 year ARI rainfall event based upon ARC TP108 were "calibrated" against the peak discharge values computed from a Rational method 5 year ARI event. CN numbers and storage coefficient factors were refined to give a combined peak discharge over all sub-catchments within 5% of Rational method values. Runoff variables satisfactorily adjusted for the five year return event were then applied in the 100 year ARI event storm.

Two catchment runoff scenarios were modeled: "Existing Development" and "Future Development". Curve numbers, times of concentration and storage co-efficient factors varied between the scenarios to reflect existing and fully developed urbanisation in the catchment.

4 CALIBRATION OF EXISTING SYSTEM

Model calibration was carried out against photographic evidence of the minor rainfall event in June 2003. The June 2003 event at Mapua was a 7 year ARI, 3 hour event, but was a 3 year ARI 24 hour event. Widespread flooding upstream of the SH60 culvert was photographed by MWH staff one hour after the heaviest rainfall ceased. Survey levels were taken subsequently of the highest water levels at a number of structures.

Comment [NJK1]: I think the event was bigger - is there a typo here? Should it be 70 year/3 hour and 8 year/24 hour or something like that.

Detailed rainfall data for the event was available from the Mapua weather station managed by EnviroLink and approximate tidal levels during the storm were also modeled from data provided by NIWA's tide forecaster facility.

Calibration to the June 2003 event was achieved by model iterations of the soil runoff parameters described by the CN values selected for each catchment, and variations in the amount of storage available in the area upstream of SH60 culvert. Following various calibration runs, it was concluded that the model could only be calibrated when the storage upstream of SH60 was excluded from the model. This was critical as it demonstrated the effect of private stopbanks on the top water levels within the area. When the storage volume was removed from the model, the best fit calibration scenario indicated a CN of 67 was appropriate. Higher CN values produced top water levels higher than recorded.

The June 2003 calibration event was not critical for the parts of the catchment with long response times, namely the lower estuary volume, where no flooding was reported. The event was critical for the upper extents of the model where the water levels are subject to high intensity rainwater in the main stream. In the absence of further flood information, the hydraulic model described above was used for modeling flood hazard and design scenarios.

Photograph 3: Armco Culvert under Stafford Drive in flood – June 2003

Photograph 4: Seaton Valley Bowling Club – June 2003

5 OBSERVATIONS FROM MODELLING

The hydraulic and hydrological models provided great insight into the behavior of the stream for various storm events. The critical observations derived from the modeling were:

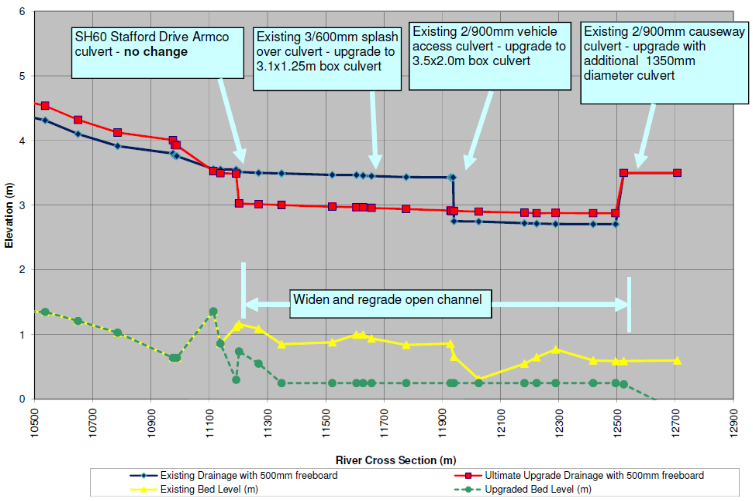
1. Critical Floor Levels

   The results from the modeling indicated that the entire Seaton Valley Stream had peak water levels higher than the target freeboard levels based on surveyed floor levels, and in some cases higher than the floor levels, in a 100 year ARI rainfall event.

2. Culvert Headloss

   The model indicated that significant headloss at the four main culverts along the Seaton Valley Stream. The backwater effect from these culvert constructions was increasing the flood area in the upper catchment. Figure 3 shows the longitudinal section of the stream with the top water level shown for both existing and upgraded scenarios.

Figure 3: Seaton Valley Waterway – top water levels

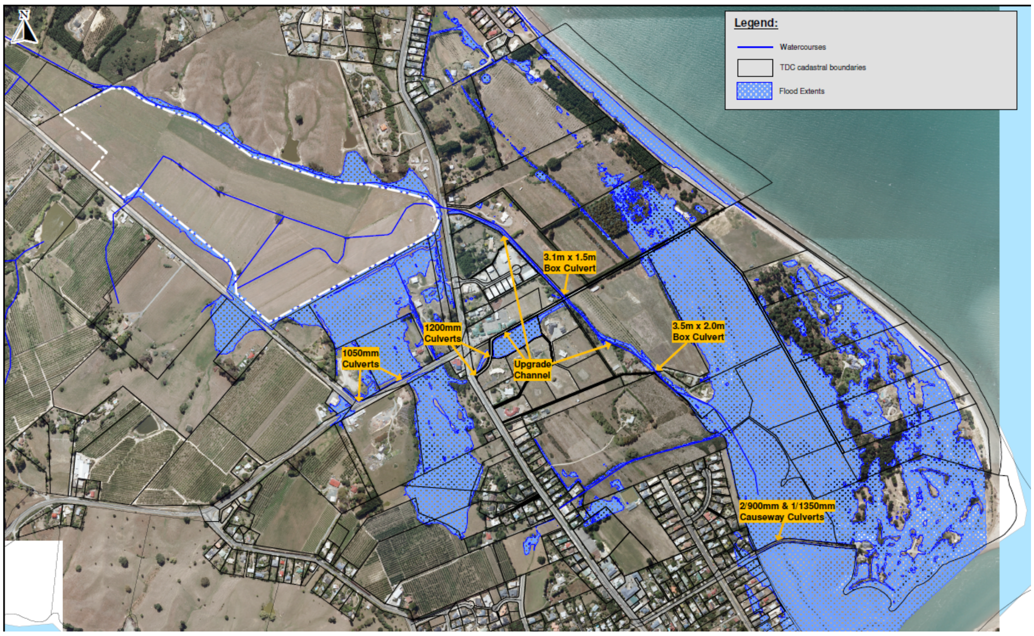


3. Flood Hazard Mapping

   The detailed LiDAR survey enabled detailed flood hazard maps to be generated for various upgrade scenarios. Figure 4 shows a typical example of the existing flood hazard map.

   These maps proved to be a very powerful way of communicating the flood risk for the community and individual landowners.

Figure 4: Flood Hazard Map, 2080 climate change



6 PROPOSED SOLUTION

Following the calculation of existing and future flood scenarios, the hydraulic model was used to evaluate design scenarios to alleviate flooding in critical areas. The final proposed solution consisted of: increasing the culvert capacity at the main culverts and widening and regrading the open channel of the Seaton Valley Stream up to the SH60 Armco culvert to the coast.

At present the three main culverts have been upgraded and the land has been purchased for the stream widening.

6.1 MAPUA CAUSEWAY (TORU STREET)

Comment [NJK2]: Reword and rephrase the sense of these sections to fit into the current paper. Past tense needed. I have checked the numbers and dimensions.

Additional capacity was required at the causeway to improve the hydraulic performance and to reduce the top water level through the floodplain. The existing twin 900mm diameter culvert was in a good condition and it was proposed to remain operational. Additional capacity was provided by a new 1350mm diameter culvert installed at 0.5m lower.

As the existing culvert is higher than the estuary level it held back water behind the causeway. During the summer months in particular, with few rainfall events to flush out this brackish water, it became stagnant, causing unpleasant odours and discolouration.

The existing culverts functioned by allowing a certain amount of reverse flows from the sea to flow into the tidal estuary behind the causeway. This functionality was retained as part of the upgrade. The existing culverts now continue to allow fresh sea water to enter the estuary area during the higher parts of the tidal cycle.

The upgrade included enhancements to improve fish passage upstream through the causeway. The key concept was to maximise the amount of tide cycle where the top 100mm of water depth (where small fish tend to swim) was open through the culverts.

6.2 INTERMEDIATE CULVERTS ON SEATON VALLEY STREAM

There were two intermediate culverts on private access ways in the Seaton Valley Stream downstream of the Coastal Highway. The culverts were under capacity in large flood events and directly responsible for significant increases in water levels upstream. By upgrading these throttle points, widespread reductions in peak water levels were gained.

The first intermediate culvert (working upstream from the causeway) had a twin 900mm diameter culvert with a vehicle access which was to be upgraded to a 3.5m by 2m box culvert. The second intermediate culvert is a triple 600mm diameter vehicle access-way which has been upgraded to a 3.1m x 1.25m box section concrete culvert.

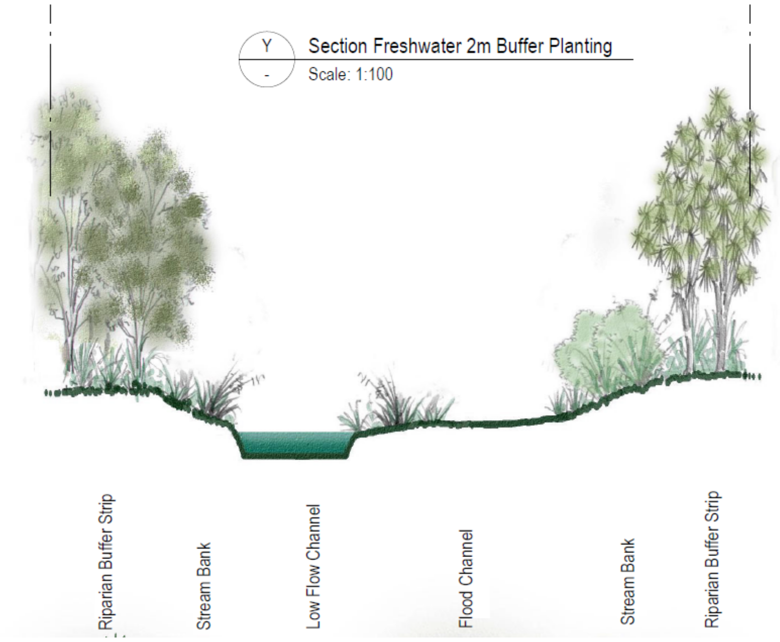
Photograph 5: Completed culvert construction

6.3 SEATON VALLEY STREAM UPGRADE

The cross section of the Seaton Valley waterway is narrow in parts and still requires regrading, widening and deepening to increase its capacity. A proposed general cross section includes a low flow channel with a flood berm at a moderately low level and side slopes set to allow maintenance. The average width of the proposed Stream channel is between 16 to 20m, an increase of between 6 to 10m over the existing cross section. The increased capacity of the channel will reduce flood levels throughout the floodplain from the causeway to SH60.

Figure 5 below details the typical cross section through the upgraded stream. The model also identified the improvements required on the minor side drains that drain into the main waterway. Generally these upgrades will be undertaken as and when the adjoining land is developed.

Figure 5: Typical Stream Cross Section



7 CONSULTATION STRATEGY

At the conclusion of the modeling and concept design stage, Council had the engineering details of the proposed upgrades, but recognised that significant consultation with the affected landowners and the community was required.

In total, the project affected 15 individual property owners and agreement was required from each landowner as the stream was on private property. At the same time, the Council needed to consult with a wider audience in relation to the consenting process. The wider consultation included the Mapua community association, iwi, Department of Conservation and environmental groups with an interest in the estuary.

It was recognised that the landowners were a special category of stakeholders and they needed to be consulted first before the wider community.

The consultation strategy had six key main elements:

1. Obtain a broad agreement for the concept of the upgrade from the landowners first, and separate this from the detailed access issues, which would be discussed later.

2. Consult with the required statutory consultants such as iwi and Department of Conservation (DoC) before wider community to ensure that Council were fully aware of the constraints.

3. Bring the wider community on board with this concept and hold a series of community meetings. Articles were also written in the Council and community newsletters to raise awareness and community acceptance.

4. Separate the project into components that limited the number of landowners agreements that were required for each main element of the project.

5. Separately seek the required land agreements for each individual work package.

6. Recognition that the consent application would be publicly notified, so obtaining written approvals for the consent was not critical.

8 LANDOWNER ISSUES

During the various rounds of consultation, a number of specific issues were raised. These included:

8.1 HISTORIC EASEMENT

There was an historic drainage easement over the lower sections of the stream. All of the land was originally in single ownership, but the land downstream of SH60 was subdivided over the years. In the original subdivision, there was an easement granted to the upstream property owner to enable him to maintain and clear the stream downstream. This required Council to also negotiate with the upstream landowner about the downstream works.

8.2 IMPACT ON THE MAPUA HOLIDAY PARK

As noted earlier, the causeway provided the only access to the Mapua holiday park. This is only a single lane road so alternative access arrangements were critical to this landowner. It was initially proposed to construct a diversion around the causeway, but this would have required extensive temporary works and construction of an embankment on the estuary.

Further negotiations were held with adjoining landowners and agreement was obtained from all parties that allowed the holiday park to use an adjoining driveway during the winter period. The holiday park decided to close for a four week period when the works were undertaken.

8.3 BOUNDARY ISSUES

At culvert two, it was discovered that the existing structure was constructed outside of the Right of Way corridor on the survey plans. Council's position was that they would only construct the new structure on the Right of Way. These types of detailed issues often only became apparent when the detailed design drawings were being prepared. These would then require further rounds of consultation with each landowner affected. In some cases, the landowners wanted independent legal surveys and legal advice before issues could be resolved.

8.4 LESSONS LEARNED FROM LANDOWNER CONSULTATION PROCESS

The consultation process is critical in a project affecting a large number of landowners. The nature of the Local Government Act, the Resource Management Act and the Public Works Act all require a certain level of consultation to be undertaken.

This project affected approximately 15 individual landowners and it took a significant amount of time and effort to get the landowners agreement. Some of the issues and lessons learned on this project were:

i. Landowners have long memories.

   In a project such as this, it is inevitable that some landowners will have had previous issues or disagreements with Council. Often they are with other departments or functions of Council, but as far as the landowner is concerned, there is one Council. For this reason, the consultation team will need to understand that until the landowner has fully aired the previous issues, future agreements cannot be reached.

ii. Political Involvement

   Notwithstanding the best efforts of staff, some property owners will want politicians involved in the consultation process. A successful strategy employed in this instance was to nominate one or two local Councillors to meet with staff and landowners when issues became difficult to resolve. Elected members can bring a different skill set to negotiations and give additional weight to discussions. When communicated and managed well, this approach can resolve issues quickly and to the mutual satisfaction of parties.

iii. Identify Cross Council Issues

   It is important to identify other Council's projects or policies that will affect the landowners concerned. In this case, a number of subdivisions were being processed by Council and some landowners wanted trade-offs between their subdivision consent conditions, for the agreement that Council required to work on private property.

   A long standing proposal for a walkway through the properties also remained uncompleted. The initial approach was to separate this issue from the drainage objectives, but in retrospect this was not really feasible and may have added to confusion with landowners in discussions.

   Council's policy team had also started a plan change process which would limit the developed land to align with the flood hazard mapping. Some landowners had concerns about this devaluing their property and were not happy with Council publishing this material.

iv. Record the Consultation

It is obvious, but it is important that all consultation is recorded, and if key issues are raised then a written response should be provided to the landowners. If Council subsequently wanted to use a more formal process such as the Public Works Act to acquire the land, then they must demonstrate that consultation has been undertaken.

v. It Takes Time

Gaining landowner agreement takes time, and generally a lot longer than initially expected. In this case, by dividing the project in discrete components it enabled the first stage to get underway, but the subsequent phases took much longer to reach agreement.

vi. Multiple Stages of Consultation are Required

The nature of the legislation that Councils operate under requires multiple stages of consultation and landowners do not necessarily appreciate or have regard to this. For example, the written approvals required of resource consent stage must not have any conditions stated by the landowner, but landowners may wish to reserve their position with respect to land purchase when making a submission. This can cause difficulties.

vii. Have a Clear Strategy

In this project, Council started the consultation on the overall upgrade strategy which was well received. On reflection, Council got locked into a long chain of consultation and negotiations with landowners. The feedback from the landowners was generally positive and agreements were promised to be "just around the corner". As the team had invested so much time and effort to gaining acceptance, they were reluctant to stop negotiations and issue formal notices.

The alternative strategy of formally issuing a Notice of Requirement (NoR) was considered but it was hard to step back and issue formal notices when consultation has progressed so far and some landowners had provided written agreements. The NoR process has advantages in the planning context, but it does not negate the need for land purchase or entry agreements in relation to property rights. In retrospect a NoR process may have provided a more straight forward and decisive process for both Council and landowners.

9 CONSENT PROCESS

All projects involving work in streams or waterways require resource consent. As this project was located in a sensitive coastal environment, additional consenting and environmental enhancements were required.

Three key environmental enhancements were identified in the scoping exercise for the project. They were fish passage of all culverts / structures, improved circulation of water in the estuary storage lagoon and cultural heritage concerns.

9.1 FISH PASSAGE

The existing culverts on the stream were a physical barrier for fish passage as they were perched above the natural stream bed. In addition, the estuary culvert had a flap gate which prevented inflow at high tides.

An ecological survey identified that the tidal estuary and stream has significant conservation values associated with native fish, wading birds and saltmarsh wetlands.

The removal of the flap gates was a concern to the upstream landowners, and additional modeling and testing of king tides was undertaken to demonstrate the effects of removing some of the flap gates. The final solution involved installing a flap gate on the new 1350 culvert but removing the flap gates from the existing 900 diameter culverts. The culverts upstream were constructed well below the final bed level to ensure that they would not be a barrier for fish passage.

9.2 IMPROVED WATER QUALITY IN LAGOON

The existing arrangement of the causeway resulted in ponding of stagnant water in the lagoon upstream of the causeway. The outlet flap gates compounded this issue and in warm weather the water became warm and pungent. To eliminate this situation, the new culvert outlet was installed lower than the existing to get full drainage at low tides. The result has been an improvement in the estuarine environment and amenity for local residents.

9.3 CULTURAL HERITAGE

The consultation with local iwi identified that there are a number of archeological sites around the lower Seaton Valley Stream area. Further investigations and consultation was held with the Historic Places Trust (HPT) and an HPT Authority, was applied for.

It is interesting to note that to get an HPT Authority, the HPT require the consent of the landowners concerned on their standard form. In this case, Council managed to convince HPT that the various approvals and agreements we had already obtained for the consent and land access were sufficient for their needs.

An iwi monitor was engaged during the earthworks to help identify any potential artifacts. None were found during the construction of the culverts.

9.4 CONSENT PROCESS

In total, a suite of six resource consents were required for the project. All of the conditions of the consent were agreed with the consent authority during the processing of the consent. As the Tasman District Council is a Unitary Authority, the consent department engaged an independent consultant to process the consent.

The consent was publicly notified, but a hearing was not required as Council undertook further consultation and volunteered additional conditions to gain acceptance. Subsequently, all submitters supported the application. In retrospect a similar outcome may have been reached, with lower cost, by proceeding to a hearing.

9.5 TIMING CONSTRAINTS

Given the sensitivity around fish migration and spawning, the consent limited the time when any work could be undertaken in the wetted channel of the stream. Only two construction windows were allowed for work in the stream:

- 1 December to 14 February
- 1 June to 14 August.

This constraint was compounded by the landowner requirements such as the Mapua Holiday Park wanting no works during the busy summer period.

9.6 COORDINATION WITH POLICY PLANNERS

Tasman District Council embarked on the statutory planning process in 2008 and the formal plan change was notified in 2010. The purpose of the plan change was to allow for future expansion of Mapua township and Ruby Bay away from the low lying flood prone land.

The key input into the plan change process was the flood hazard mapping generated by the hydraulic modeling and overlain on the LiDAR survey data.

All of the land prone to flooding from the Seaton Valley Stream was rezoned "Classed Rural" which would prevent future sub division of the land.

This process shows the benefits of Councils undertaking a flood hazard assessment and working collaboratively across Council departments.

10 CONCLUSION

A significant investment has been made by Tasman District Council in upgrading the Seaton Valley Stream. With the three major culverts, the hydraulic capacity has been significantly increased by minimising the headlosses through the system.

The detailed hydraulic modeling and flood mapping were a major undertaking but the outputs were invaluable in plan change process.

This is a small but important example of how stormwater construction should be at the forefront of policy planners thinking when defining development areas. Stormwater drainage is the one service that can define the land form.

The consultation process with such a large number of landowners presented a challenge and it took a significant amount of time and effort. In hindsight, a more formal process for the consent and designation of the required land could have been a better approach.

One advantage of the designation route is that it enables the Public Works Act to be invoked so that land may be compulsorily acquired if no agreement can be reached.

It must be recognised by asset managers and promoters of schemes that the consenting and land acquisition processes are key / critical path activities which can take a significant amount of time.

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