NUTRIENT SMART MANAGEMENT

Introduction

The Nutrient Smart Management Project was delivered through a partnership between the NSW Department of Primary Industries (DPI) and the Hawkesbury–Nepean Catchment Management Authority (Hawkesbury–Nepean CMA). The project focussed on reducing diffuse nutrient loads from agricultural activities downstream of the major water supply dams of the Hawkesbury–Nepean river system by engaging landholders in capacity building, education and on-ground works. The main agricultural land uses that were targeted were grazing, dairy, market gardens, turf farms and farms with small lot sizes.

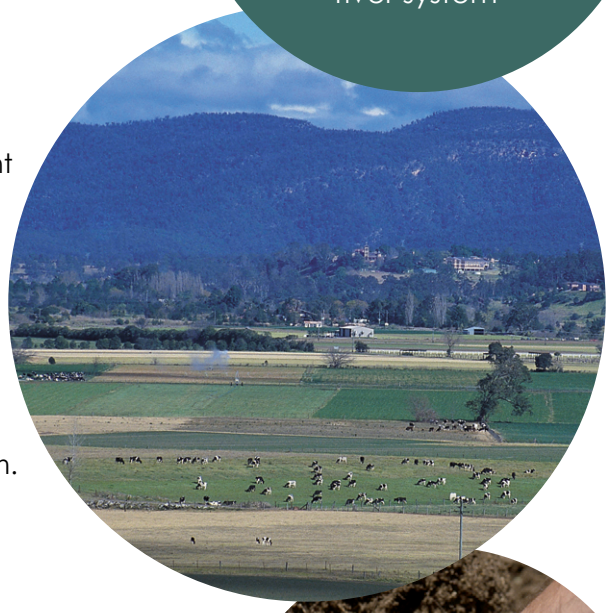
The Nutrient Smart Management Project had four concurrent phases:

- identifying properties in the Hawkesbury–Nepean catchment where cost-effective nutrient management improvements could be made
- extension and capacity building
- on-ground works, including compost treatment
- monitoring, evaluation and reporting.

The project was funded by the Australian Government under the *Water for the Future* initiative and received $7 million of the total $77.4 million allocated to the overarching Hawkesbury–Nepean River Recovery Program. In addition, participating landholders contributed $3.9 million.

The project was commonly known under the title NutrientSmart Farms, and operated in tandem with the Water Smart Farms Project. Together the two projects were known as Smart Farms.

The Nutrient Smart Management Project focussed on reducing diffuse nutrient loads from agricultural activities downstream of the major water supply dams of the Hawkesbury–Nepean river system



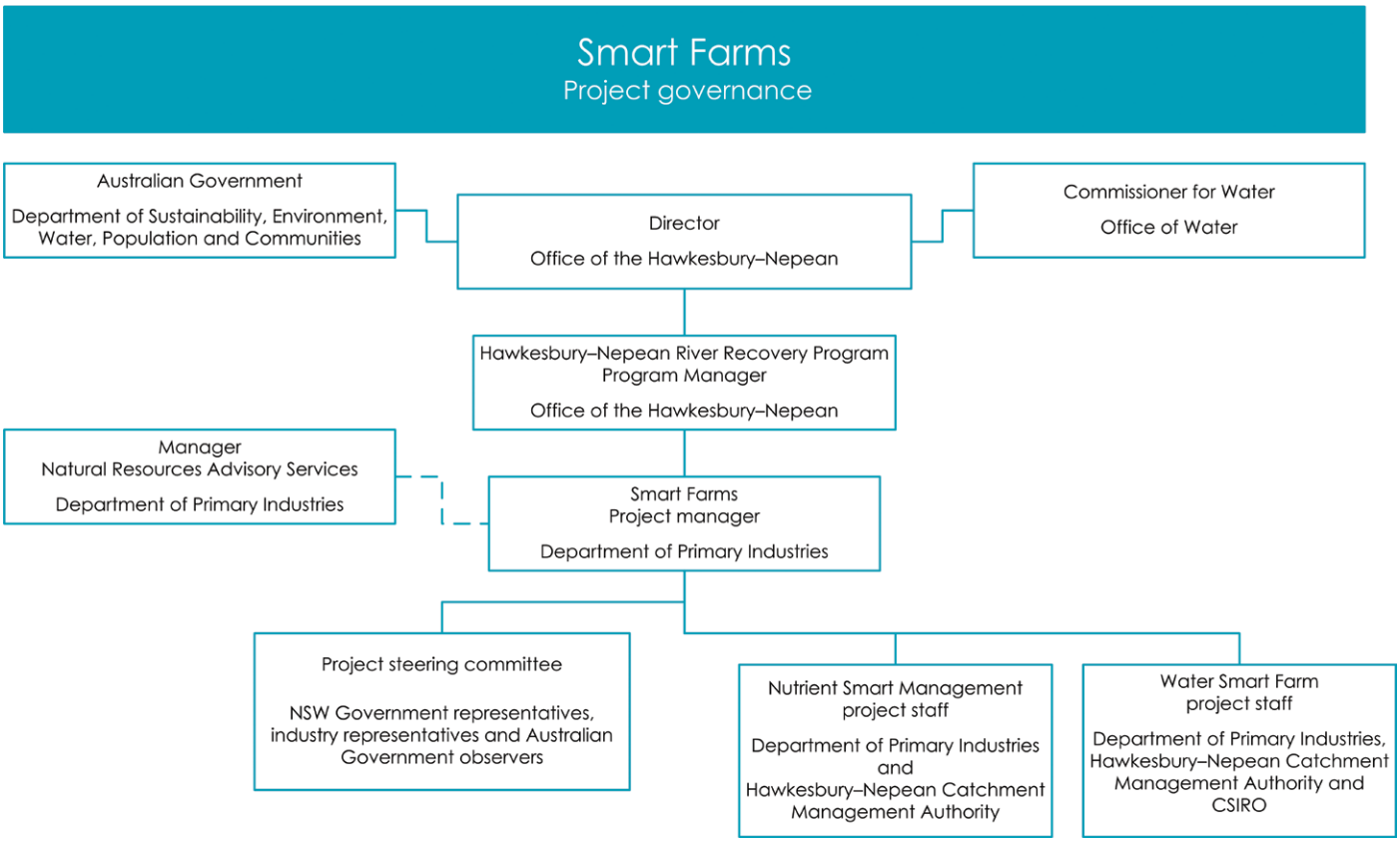
Objectives

The objective of the Nutrient Smart Management Project was to improve water quality in the Hawkesbury–Nepean river system by undertaking on-ground works and capacity building/education with primary producer landholders. Specifically, the project aimed to reduce exports to the river system of total nitrogen by 27 tonnes per year and of total phosphorus by 6 tonnes per year.

Methods

The Nutrient Smart Management Project was managed by DPI and delivered in partnership with the Hawkesbury–Nepean CMA. The Hawkesbury–Nepean CMA administered the works agreements (contracts) for all Nutrient Smart Management incentive-funded on-ground works projects, managed the delivery of the incentive finances, and tailored and maintained project information databases designed to capture and manage spatial and non-spatial information for the project. Figure 26 illustrates the project governance.

Figure 26. Smart Farms Project governance



DPI appointed a project manager in late 2008 and built a team of 12 staff from both the Hawkesbury–Nepean CMA and DPI over the life of the project to deliver training and develop on-ground works projects. A further 14 staff from the Hawkesbury–Nepean CMA and DPI shared positions in the Nutrient Smart Management and Water Smart Farms projects. These team members managed data and reporting, finances, legal matters, evaluation and communication services.

The project manager and team leaders held weekly teleconferences throughout the life of the project to ensure that issues were managed and, in the final six months, met face to face every fortnight. Weekly reports were generated and circulated to monitor progress and the financial management system was interrogated weekly to ensure budget control. Other meetings were held when needed. Nutrient Smart Management team meetings were held on a monthly basis and informally as required.

The Nutrient Smart Management and Water Smart Farms projects operated a joint Smart Farms Project Steering Committee. Committee members representing landholders were nominated by experienced local staff and invited to join the steering committee in early 2009. Members were chosen because they held representative roles for their respective industry or grower groups and were also regarded as prominent and successful industry figures. The steering committee was formed and operated under an agreed terms of reference and was chaired by the project manager. The committee met quarterly (11 times) over the life of the project and provided valuable input into many aspects of the project and its delivery.

Background and context

The Nutrient Smart Management Project operated in the lower Hawkesbury–Nepean catchment, downstream of the major water supply dams. The focus was on reducing nutrient loads in surface run-off from commercial farms, but the project team also engaged landholders from all other types of land uses in the project area.

Range of project activities

The major activities undertaken by the Nutrient Smart Management Project were:

- engaging the community and providing information
- developing incentive-funded on-ground works projects with landholders that led to nutrient export reductions
- developing and delivering relevant nutrient export reduction training activities
- providing free soil and water testing to landholders.

Research

In order to prioritise grant investment and provide base level data for assessing the proposed on-ground works projects, the project team evaluated the potential reductions in nutrient exports associated with various land use practice changes.

It was found that the land uses with the largest potential reductions in nutrient exports were field vegetable production and dairy farming, however the literature review revealed very little information on which to base the estimated reductions and a limited understanding of the processes required to achieve them.

To ensure that on-ground works funded for these land uses achieved suitable results, the project manager commissioned a research project to complement the on-ground works activities. The research provided valuable data which was used to guide the project team when allocating incentive funding for on-ground works in these two industries.

The principal findings of the field vegetable production research were:

- There was strong statistical evidence ($P<0.01$) that compost application increased the water-infiltration properties of soil, thus reducing the volume of run-off.
- As a consequence of reduced nutrient inputs/accumulation and improved soil physical properties, the use of compost at 62.5 tonnes per hectare resulted in approximately a 50 per cent reduction in nitrogen and phosphorus exports in surface run-off.
- Adaptive nutrient management strategies to manage compost inputs in combination with inorganic fertilisers or poultry litter can achieve both production and environmental objectives.

Greenhouse industry field day, September 2009

The principal findings of the dairy farming research were:

- Dairy laneways have run-off volumes that are on average several times higher than those from grazed paddocks, leading to nutrient export rates that are much higher than those from grazed and effluent/manure-reuse paddocks.
- Laneway management to reduce nutrient exports should be focussed on areas nearest the dairy, particularly those with high slopes.
- Since laneways are relatively small compared to the total farm area, they contribute only a small proportion of whole-of-farm nutrient exports (13 per cent or less) while intensively grazed paddocks account for 83 per cent or more of exports. A combination of activities to reduce nutrient exports from both laneways and grazed paddocks can deliver whole-of-farm nutrient export reductions (Dougherty, 2012).

An Australian National University honours student conducted additional research by examining nutrient movement under poultry litter piles as compost in an honours thesis.

The research indicated that while nutrients can leach from stockpiles, the majority of nutrients remain within the top 10 centimetres of soil. The research also confirmed that organic matter from poultry litter increases soil's cation exchange capacity, resulting in increased nutrient buffering by soils in contact with the poultry litter (Regan, 2011).

The Nutrient Export Monitoring Project, led by the Office of Environment and Heritage, also provided useful data and was a valuable partner. The Nutrient Smart Management Project provided six of the seven sites intensively monitored by the Nutrient Export Monitoring Project. More information on the Nutrient Export Monitoring Project can be found on pages 108-124 of this report.

Information management

Preliminary activities prior to the start of the project in April 2009 allowed rapid progress upon project commencement. These activities included briefing staff, setting up protocols and accounts for soil and water testing, writing a literature review of nutrient losses from farms (focussing on run-off from a variety of sources) and promoting the project to landholders and other stakeholders such as rural contractors.

Extensive use of two centralised electronic libraries was made to share resources amongst DPI project staff. Both libraries used the Lotus Library program, a feature of DPI's Lotus Notes email system and housed latest versions of documents, milestone reports and minutes of meetings.

Two databases, the Catchment Information Management System (CIMS) and the Land Management Database (LMD), developed by the Hawkesbury–Nepean CMA, were used to track progress and generate reports and contracts. CIMS is a live database that can store a large amount of non-spatial information on individual projects and readily collate this information in a variety of useful reports. LMD uses geographic information systems software to complement CIMS and provide a spatial dimension to the CIMS data.

Inspecting a nutrient retention pond at the Freemans Reach field day, September 2011

Both databases were extensively modified and customised to meet the data management, financial management and reporting requirements of the Nutrient Smart Management Project. Some key specific examples of system modification for the project included:

- additions to the LMD to cater for the activities to be documented and recorded in the Nutrient Smart Management Project
- the creation of an attribution guide to standardise individual project reporting and ensure accurate and detailed reporting for the overall project
- the creation of a new CIMS portal that enabled access for both Hawkesbury–Nepean CMA and DPI staff to the CIMS database
- the creation of a suitable project structure in the financial management system to ensure the financial management of the project was in line with the non-financial reporting.

Monitoring, evaluation and reporting were undertaken throughout the entire project. All on-ground works involved nutrient calculations and a final report, case study and landholder survey. All training activities were evaluated.

Community engagement

Particularly in the early stages, Smart Farms was extensively promoted using general and targeted field days, meetings, mass media, industry organisations, mail outs and word-of-mouth. Many of the Smart Farms project officers were extension staff well known in the project area. Events were either targeted to a particular subcatchment or locality, or a particular industry group, such as dairy farmers, turf farmers or greenhouse vegetable growers. All promotional events were planned to raise awareness of the projects and the incentive program.

The Hawkesbury–Nepean CMA had a strong network of local landholders, community members and Landcare contacts to tap into for sourcing appropriate sites for projects. To attract expressions of interest to participate in the Nutrient Smart Management Project, DPI and the Hawkesbury–Nepean CMA conducted advertising and prepared targeted media releases that resulted in numerous media articles in local papers. These media releases generally profiled a landholder who had already participated in the project and welcomed others to contact the project team to get involved.

The Hawkesbury–Nepean CMA undertook an extensive landscape analysis to identify key locations in the project area where erosion was clearly contributing soil to waterways. Aerial photo interpretation was undertaken across the project area followed by ground-truthing of key sites. For these locations, key properties were identified and the relevant landholders were contacted directly and invited to participate.

A brochure, posters and other promotional material as well as standard templates for publications were developed in the first few months of Smart Farms. A communication strategy was developed by Smart Farms team members and endorsed by the Office of the Hawkesbury–Nepean.

Developing on-ground works projects

DPI and the Hawkesbury–Nepean CMA shared responsibility for developing on-ground nutrient management projects for the Nutrient Smart Farms Project.

On-ground works projects were usually initiated when landholders contacted DPI requesting a farm visit. Project officers then visited the landholder and discussed the work required. If works met project objectives, and the landholder was able to provide adequate in-kind contributions, a proposal was developed. Proposals were then assessed by the Nutrient Smart Management Assessment Panel against the following six criteria:

1. Technical feasibility
2. Project sustainability – will the works result in a short or long-term improvement?
3. Applicant's resources and commitment
4. Project focus – environmental benefit versus private benefit
5. Connectivity to waterways
6. Estimated cost effectiveness.

In order to predict the likely nutrient benefits of individual proposals, a literature review was undertaken to determine:

- nutrient export rates for a range of agricultural land uses (e.g. field vegetables, dairy, intensive and extensive grazing and hobby farms)
- information on the efficiency of proposed nutrient reduction activities (e.g. stock exclusion fencing, improved fertiliser management, increased perimeter vegetation and application of compost).

Site-specific factors, such as existing vegetation or the presence of a dam, were also considered in the analysis.

The cost effectiveness was assessed on the basis of a nominal value (in dollars per kilogram), determined by dividing the total grant budget by the overall nutrient export reduction objectives. This nominal value then provided a benchmark to assess the cost effectiveness of individual project proposals.

Once projects were approved by the Nutrient Smart Management Assessment Panel, details of all projects were entered into the CIMS and LMD databases and the financial management system to coordinate incentive payments. Assessment panel approvals were then forwarded to the Hawkesbury–Nepean CMA program manager or general manager to release funding.

The on-ground works projects developed by the Hawkesbury–Nepean CMA generally focused on landscape scale interventions such as:

- fencing to exclude livestock from natural waterways, often in combination with re-vegetation
- soil conservation works (e.g. halt gully erosion or bank slumping).

An eroded streambank prior to fencing (above) and a dairy laneway prior to fencing (below)

In comparison, on-ground works projects developed by DPI tended to focus on those specific to primary industry operations, often involving intensive nutrient use, such as:

- creating nutrient retention ponds and earthworks to control run-off on horticultural farms
- recycling greenhouse drainage water
- upgrading dairy effluent systems
- supplying greenwaste compost to improve soil condition and water infiltration
- improving fertiliser application practices (e.g. distributing through an irrigation system in an orchard)
- improving poultry manure storages on horticultural farms.

The Hawkesbury–Nepean CMA searched the Aboriginal Heritage Information Management System database for all projects involving any known sites of Aboriginal cultural heritage in the area. The Hawkesbury–Nepean CMA's catchment officer for Aboriginal communities inspected all project sites that were in the vicinity of known sites of Aboriginal cultural heritage to ensure the proposed works would not negatively impact on the cultural significance of the site.

Implementing on-ground works projects

In most circumstances, 10-year contracts were drafted for approved on-ground works projects. These contracts between the Hawkesbury–Nepean CMA (which disbursed all grant monies) and applicants typically included:

- landowner and property details
- a description of the works to be undertaken
- details of the nutrient savings predicted to be achieved by the project
- a detailed budget describing both the grant contribution and the proponents in-kind and/or cash contributions
- a description of the project outputs
- a map showing the location and nature of the works.

Dairy effluent solids separator (above); compost generating heat to achieve pasteurisation (below)

In most cases, a simple, two-party agreement between the landholder and the Hawkesbury–Nepean CMA was established. Where the applicant was not the landowner or not an owner of all the lots where work would occur, a three-party contract including the landowner was required.

Upon receipt of signed works contracts from landholders, the Hawkesbury–Nepean CMA executed the works agreement, approving the release of funds for the on-ground works. Depending on the size, value or nature of the project, payments were either made in one instalment or were staged.

Finalisation and certification of on-ground works projects

Hawkesbury–Nepean CMA and DPI staff conducted on-site assessments of completed works and forwarded a final report, case study and landholder evaluation to the Hawkesbury–Nepean CMA. These documents confirmed that works had been completed according to the contract and to a satisfactory standard, and assisted with the reporting and evaluation of the project outcomes. For projects that had staged payments, this step allowed the release of the final payment.

Results

The Nutrient Smart Management Project has achieved its objective of improving water quality in the Hawkesbury–Nepean river system through a successful on-ground works program supported by effective communication and landholder capacity building and education. It has exceeded its nutrient export reductions objectives of 27 tonnes per year of total nitrogen and 6 tonnes per year of total phosphorus.

Communication activities

To promote the Nutrient Smart Management Project, various publications were produced, including a brochure, posters, and web pages. A range of more targeted communication outputs were also produced, as summarised in Table E1.

Table E1
Nutrient Smart Management communication output summary – direct communication

Activities		**Stakeholders engaged**	
Type	Number	Landholders/ participants	Industry members
Education/training/workshop	11	174	24
Field day – Smart Farms	13	273	54
Field day – stall at other event	14	430	452
Individual engagement	2	8	0
Newsletter	31	625	1167
Stakeholder meeting	21	261	129
Total	**92**	**1771**	**1826**

As well as direct communication with stakeholders, the Nutrient Smart Management project team produced eight media releases, 21 newspaper articles and nine online articles, and gave one radio interview.

A variety of multicultural activities were also undertaken to cater for the cultural diversity of agricultural stakeholders in the Hawkesbury–Nepean catchment. These activities, summarised in Table E2, were facilitated by bilingual project officers within the Nutrient Smart Management team.

Table E2
Nutrient Smart Management multicultural activities

Language	**Translation type**	**Number of activities**	**Number of landholders engaged**
Arabic	Verbal	3	12
	Written	4	~
Chinese - Cantonese	Verbal	13	163
	Written	6	~
Vietnamese	Verbal	1	1
	Written	3	~
Totals		**30**	**176**

A number of journal articles and conference papers were also prepared as part of the project communications:

- Brunton V (2011) Compost for the Hawkesbury–Nepean Catchment. *BioCycle* **52**:1
- Brunton V and Fahey D (2011) Specifications for composted soil conditioner for the Hawkesbury–Nepean River Recovery Project. International Symposium for Organic Matter Management & Compost Use in Horticulture, Adelaide, South Australia.
- Senn A (2011) Nutrient Retention Ponds – what role on horticultural farms? Irrigation Australia Conference - Irrigation 2011: New Horizons Fresh Ideas, Hobart, Tasmania.
- Senn A, O'Connor J, Dougherty W and Machar S (2011) Assessing on-ground works that reduce farm nutrient exports. Australasia Pacific Extension Network Conference, Armidale, New South Wales.
- Senn A, Upjohn B, Machar S, Yiasoumi W and Bennett P (2011) Accountability in action – responsible disbursement of grants for environmental works on farms. Australasia Pacific Extension Network Conference, Armidale, New South Wales.

Education and capability building activities

Field days, workshops, bus trips and training activities were held throughout the life of the Nutrient Smart Management Project. These events provided information about the project, and demonstrated examples of on-ground works that were eligible for funding. The events were either dedicated Nutrient Smart Management events or events hosted by others where the project had a significant presence.

Each formal event and training activity was evaluated to help refine subsequent activities. This included evaluation undertaken after site visits to inspect completed on-ground works.

Tables E3 and E4 summarise the demographics of participants and level of engagement for education and training activities as estimated by surveys of 238 attendees (41 per cent of total attendance) from 18 of the activities.

Table E3
Nutrient Smart Management training activities – breakdown of attendees

Attendees	%
Farmers	66
Industry	10
Government	21
Other	3

Table E4
Nutrient Smart Management formal events – attendees' satisfaction with event content

Questions	Most common response	% of respondents
Event met my expectations	'Agreed' or 'strongly agreed'	81
Instruction received was of a high standard	'Agreed' or 'strongly agreed'	83
Event was presented at a level I could understand	'Agreed' or 'strongly agreed'	91
Topics were useful	'Agreed' or 'strongly agreed'	88
Training materials were clear and helpful	'Agreed' or 'strongly agreed'	80
Pace of the event	'About right'	93
Recommend the event to others	'Yes'	91

Table E5 shows that brochures and word-of-mouth communication were the most effective mechanisms for promoting events.

Table E5
Nutrient Smart Management formal events – how attendees found out about events

Method	% of respondents
Brochures	33
Word-of-mouth communiation	29
Internet or email	17
Radio/TV	1
Newspaper/magazine	4
Other	16

Evaluation questionnaires completed by 68 of the 114 attendees of the compost workshops indicated that these training events would help farmers improve their on-ground practices, specifically:

- 96 per cent of respondents agreed or strongly agreed that their understanding of the benefits of adding compost to the soil had improved after the workshops.
- 76 per cent of respondents were confident that they could purchase compost appropriate to their farm.
- 88 per cent of respondents said they would use compost on their farm in the future.

Common evaluation questions were asked at a series of field days targeting industry groups such as Chinese vegetable growers and turf growers, and at an introductory workshop. Fifty-one attendees responded. The evaluation found that, prior to the events:

- 14 per cent of respondents strongly agreed that they had a good understanding of environmental water quality, which increased to 44 per cent after the workshop
- 27 per cent of respondents strongly agreed that they had a good understanding of how farming can affect environmental water quality, which increased to 38 per cent after the workshop
- 55 per cent of respondents strongly agreed or slightly agreed that they had good understanding of how nitrogen and phosphorus move through soil and water, which increased to 88 per cent after the workshop.

Other findings of the evaluation surveys were that:

- the majority of respondents correctly identified some causes associated with water of low environmental quality; 71 per cent identified high nutrient levels, 66 per cent identified turbidity, and 66 per cent identified low oxygen levels
- the majority of respondents correctly identified some causes of poor water quality; 69 per cent identified decay of vegetation, 67 per cent identified run-off high in nitrogen, 65 per cent identified disturbance by animals, 53 per cent identified sheet erosion, and 49 per cent identified gully erosion
- 66 per cent of respondents correctly identified that most phosphorus is lost from paddocks due to surface run-off
- 76 per cent correctly identified that the statement 'phosphorus moves easily through soil' was false while 84 per cent correctly identified that the statement 'nitrogen moves easily through soil' was true.

Training workshops were also held to assist landholders in soil and water management. Following these, attendees were asked which aspects of the training would be used on their farms. The results are shown in Table E6.

Table E6
Nutrient Smart Management formal events – soil and water management workshop results

Method	% of respondents who would use this practice on their farm
Identifying soil layers	71
Identifying soil texture	71
Identifying a crop's effective root zone	59
Calculating readily available water	82

In addition, 20 per cent of respondents said they had tested their soil fertility in the past, 75 per cent said they would test their soil fertility in the future, while 5 per cent said they would consider testing it.

The events have significantly increased attendees' understanding of improved soil and water management practices and willingness to implement these in the future.

Farm-On survey

As part of the Nutrient Smart Management Project, rural land managers in the Hawkesbury–Nepean region were invited to participate in the Nutrient Smart Management Farm-On Survey. The aims of the survey were to:

- gather information about current land management practices and environmental conditions
- improve understanding about the impacts of management and the potential for long-term nutrient management improvement
- assist in planning and delivering future natural resource management projects.

The Survey recorded data that described a range of land use practices including farm fertiliser programs and soil management practices. The survey also captured data on landholders' perceptions of current land condition and water quality.

Survey responses were gathered in three ways:

1. An online version of the survey was developed and promoted widely through targeted emails and general media with 75 responses.
2. Smart Farms project officers undertook surveys with 100 landholders already engaged in Smart Farms.
3. 300 landholders not already engaged in Smart Farms participated by telephone.

Key findings from the Farm-On survey were:

- 80 per cent of respondents owned their properties
- 70 per cent of respondents ran their properties as commercial enterprises
- field vegetables, stone fruit and turf were the most common farming enterprises of the respondents
- golf courses were the main non-agricultural land use of the respondents.

On-ground works projects

The Nutrient Smart Management Project helped landholders to develop and fund 187 on-ground nutrient management works projects as detailed in Table E7.

Table E7
Nutrient Smart Management capital works summary

Project description	Number of projects
Composted soil conditioner (sourced only from greenwaste) was applied to improve soil condition and lessen run-off	62
Solid and liquid waste management on dairy farms was upgraded	14
Cattle were excluded from natural waterways by fencing and these projects often had a revegetation component	30
Fertiliser was applied to orchards and vegetable farms via irrigation systems and other more targeted methods	10
The nutrient-rich drainage water of greenhouse enterprises was captured and reused on outdoor or indoor crops	6
Nutrient retention ponds and associated earthworks captured 'first flush' run-off from horticultural farms and reused it via irrigation	24
On vegetable and turf farms, poultry manure storages were improved by better containing the material on a raised impervious base with bunding (concrete floors or walls) and also by abandoning poorly sited storages	18
Eroding gullies and riverbanks were stabilised	12
Turf aerating machines were funded to lessen run-off and improve water infiltration	11
Total	**187**

To prepare for on-ground works projects, project staff conducted over 1100 soil, water and plant tissue tests. The tests were mostly undertaken before on-ground works were funded to determine any issues to be addressed.

All aspects of Nutrient Smart Management activities were captured spatially in maps. Maps were produced for all on-ground works projects to detail the scope and alignment of works. The overall outputs for each activity were summarised in final reporting maps.

The maps produced for the on-ground works projects were:

- distribution and value of Nutrient Smart Management incentives (grants)
- distribution of Nutrient Smart Management events
- distribution and size of Nutrient Smart Management nitrogen export reductions
- distribution and size of Nutrient Smart Management phosphorus export reductions
- distribution of landholders engaged in the compost project
- land use in the Smart Farms area
- distribution and results of Smart Farms soil sampling
- distribution of Smart Farms water sampling sites.

Rainwater harvesting pipe works in progress (above) and the completed rainwater tank (below) at a greenhouse vegetable demonstration site in Rossmore

The maps can be viewed by searching for 'Hawkesbury-Nepean River Recovery' on the Office of Water website and viewing the Smart Farms section.

According to Nutrient Smart Management project officers, works inspected up to the end of the project were installed to a high standard and were functioning as intended.

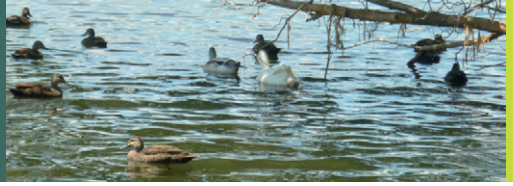
Feedback from a survey sent to landholders has also been positive. Some examples include:

- 'We are thrilled with the results of the project. Work was carried out fast and now I've got a safe dam,' Carol and Eric Hayward.
- 'A rewarding experience to see the paddocks looking good,' Carolyn Gregory.
- 'This project has been a very rewarding experience and will prevent contamination of the Grose River,' Paul and Jeanne Rasmussen.
- 'It is easier to control and manage the cattle and they are not in the creek areas,' Peter Costelloe.
- 'I no longer spend time trying to find my cattle as they are prevented from entering the creek area,' Frank Daniele.
- 'We are really happy with the work on ground and the area looks very good now compared to what it looked like before' Kaye Morris.
- 'It is gratifying to see the regeneration of native plants and groundcovers which will help bind the river bank,' Gillis Broinowski.
- 'Extremely happy with the work done... I am sure it has solved the problem,' Julie Sheppard.

Soil tests were undertaken on private farms for specific site-related issues, rather than to determine general soil characteristics within the project area. The sampling location on each property varied depending on the reason for sampling. Some samples were collected in relation to a specific issue and focused on areas of interest such as drainage lines, effluent dispersal areas, or the soil surrounding manure storage areas.

The rest of the samples were collected at the farmer's request, with many samples coming from good and bad areas as a comparison, or a single sample from every field so that they could develop a picture of what was happening on their property at that time.

Due to this variability in sampling, wider use of the results to assess levels in agricultural soils is



not possible. The levels of nitrogen and phosphorus observed in the soil samples generally exceeded the suggested minimum value for each industry, but were extremely variable due to the site-specific nature of the testing. A summary of the results is provided in Table E8.

Table E8
Nutrient Smart Management soil test result summary

Test	Industry	Number of samples	Mean (milligrams per kilogram)	Range (milligrams per kilogram)
Nitrate (nitrogen)	Grazing	72	13.5 (4.2)	1 - 240
	Cropping	12	48.3 (25.2)	1.6 - 310
	Dairy	135	56.7 (4.5)	3.7 - 270
	Field vegetables	60	45.8 (6.3)	2.7 - 300
	Orchard	105	25 (3.1)	1 - 200
	Ornamentals	22	131.9 (103.5)	1.0 - 2300
	Turf	52	33 (5.5)	3.1 - 250
Phosphorus (Colwell)	Grazing	12	47.1 (8.6)	5 - 510
	Cropping	72	274.8 (150.9)	8.3 - 1900
	Dairy	135	284.8 (25.4)	6.6 - 2000
	Field vegetables	60	374.9 (39.2)	39 - 1400
	Orchard	105	138.5 (12.5)	5 - 540
	Ornamentals	22	223.4 (40)	5 - 760
	Turf	52	222.9 (32.4)	6.4 - 1700

Note: Bracketed numbers represent the standard error, which is a measure of the 'scatter' or variability of these measurements.

Compost program

As part of the project, fully subsidised compost was spread over 252 hectares of farmland, covering six types of farming industries. Over 300 soil tests were also conducted before and after the majority of the compost applications.

The aim of the compost program was to reduce nutrient exports to the Hawkesbury–Nepean river system from farms by applying composted greenwaste to improve soil structure and moisture retention. To initiate the process, a set of detailed specifications was developed to establish quality parameters and provide fit-for-purpose compost. These specifications were also used to reassure farmers that the risks of applying compost were minimal, following some previous local experiences with contaminated and poor-quality compost.

Soil tests were undertaken on farms that received compost, both before and after application. The results indicated that slight increases in soil carbon were being realised. It is expected that over time soil carbon levels will continue to improve (especially if farmers continue annual compost applications) and continue to contribute to nutrient and water retention in the long term.

Virginia Brunton from the Nutrient Smart Management Project compost team accepting the Compost Australia leadership award

Landholders who were involved in the compost component of the project were also surveyed to gauge their satisfaction and opinions on compost use and changing farming practices. Participants were first contacted by email and asked to complete a short survey and those who didn't respond were contacted by telephone. Forty-four responses were received from the 62 landholders who received compost. The key findings from the survey were:

- The majority of the respondents were very satisfied with the quality of the compost they received and had spread all of it.
- Over 60 per cent of farmers had heard of using compost in agriculture before the project began.
- After use, the general response was that it was good for soil and plant health and 86 per cent of respondents said they would recommend its use to others.
- The majority (64 per cent) of all respondents commented that compost appeared to help with water retention and crop/plant health, with the crops germinating earlier, having better growth (thick foliage) and looking a darker green than those in non-composted fields.

Despite the positive response, many farmers expressed concern at the cost of buying good quality compost and only about 50 per cent said they could change their farming practices after applying the compost. The rest said the compost, at the rate applied, was not having enough of an effect or not enough time had passed for it to begin to have an effect.

Due to its success, the Nutrient Smart Management Compost Project won the Leadership Award for the most innovative recycled organics product design for a specific application at the Compost Australia national awards ceremony held on 27 August 2011.

Nutrient export reductions

The Nutrient Smart Management Project aimed to reduce nutrient exports to the Hawkesbury–Nepean river system by 27 tonnes per year of nitrogen and 6 tonnes per year of phosphorus.

The literature review prepared at the commencement of the Nutrient Smart Management Project determined estimates of nutrient exports from various rural land uses, and the effectiveness of various interventions at reducing nutrient exports. The outcome of the review provided the basis for estimating the nutrient export reductions likely to be achieved from individual on-ground works projects.

DPI's self evaluation of the project estimated that it achieved nutrient export reductions of nearly triple the objective for both nitrogen and phosphorus, reaching 76.1 tonnes per year of nitrogen and 17.4 tonnes per year of phosphorus. All on-ground works projects were assessed for nutrient reductions to determine incentive levels.

A summary of the estimated nutrient export reductions achieved by each project type is provided in Table E9.

Table E9
Nutrient Smart Management estimated nutrient export reductions

Project type	Number of projects	Nutrient reductions	
		Nitrogen (tonnes per year)	Phosphorus (tonnes per year)
Applying compost	62	~	~
Dairy effluent management	14	14.63	2.97
Stock exclusion fencing/re-vegetation	30	6.21	0.97
Fertiliser management	10	6.06	0.87
Recycling greenhouse drainage water	15	7.32	1.12
Nutrient retention pond	24	14.13	3.06
Storing poultry manure	9	1.64	1.02
Spillway/flume/erosion control	12	24.97	6.85
Turf aerator	11	1.18	0.59
Totals	**187**	**76.14**	**17.45**

The Nutrient Export Monitoring Project, managed by the Office of Environment and Heritage, undertook an external evaluation of the nutrient export reductions achieved by the Nutrient Smart Management Project. The external evaluation yielded nutrient export reduction estimates that varied from those reported here, as it was based on different nutrient export and reduction data. However, the Nutrient Export Monitoring Project also concluded that the nutrient reduction objectives for the Nutrient Smart Management Project have been exceeded by a significant margin. For more information, refer to pages 121-124 of the Nutrient Export Monitoring Project section of this report.

Compost awaiting spreading on a farm at Richmond

Learnings

Learnings resulting from the Nutrient Smart Management Project are:

- Using bilingual officers to train and educate landholders is vital to the success of any program with a significant number of culturally and linguistically diverse participants. DPI has used bilingual officers for previous projects with noted success. The Nutrient Smart Management Project has reinforced the benefits of this approach.
- The framework for implementing on-ground works projects requires flexibility to derive a variety of solutions tailored to individual landholder needs.
- Operating the Nutrient Smart Management and Water Smart Farms projects under the overarching 'Smart Farms' banner allowed for streamlined communication and administration of both projects.
- Grant funding opportunities such as the Hawkesbury–Nepean River Recovery Program provide significant incentive for landholders to invest in improving their water and nutrient management systems and to carry out work that would not otherwise be undertaken.
- The most cost-effective nutrient management strategies implemented under the Nutrient Smart Management and Water Smart Farms projects were:
  - improved fertiliser management on vegetable farms
  - run-off and leachate recycling at nurseries
  - improved manure storage on field vegetable farms
  - improved effluent management at dairy farms.
- The adoption of landholder management practices and technologies is most effective when supported by appropriate information and education.
- Strong statistical evidence ($P<0.01$) shows that compost application increased water retention properties of soil and reduced the volume of run-off.
- As a consequence of reduced nutrient inputs/accumulation and improved soil physical properties, the use of compost at 62.5 tonnes per hectare resulted in approximately a 50 per cent reduction in nitrogen and phosphorus exports in surface run-off.
- Adaptive nutrient management strategies to manage compost inputs in combination with inorganic fertilisers or poultry litter can achieve both production and environmental objectives.
- Dairy laneways have run-off volumes that are on average several times higher than those from grazed paddocks, leading to nutrient export rates that are much higher than those from grazed and effluent/manure-reuse paddocks.
- Laneway management to reduce nutrient exports should be focussed on areas nearest the dairy and/or with high slopes.
- Since laneways are relatively small compared to the total farm area, they contribute only a small proportion of whole-of-farm nutrient exports (13 per cent or less) while intensively grazed paddocks account for 83 per cent or more of exports. A combination of activities to reduce nutrient exports from both laneways and grazed paddocks can deliver whole-of-farm nutrient export reductions.